Railway Age Gazette
MECHANICAL EDITION
INCLUDING THE
AMERICAN ENGINEER

Published on the First Thursday of Every Month by the
SIMMONS-BOARDMAN PUBLISHING COMPANY,
Woolworth Building, New York, N. Y.

CHICAGO: Transportation Bldg. CLEVELAND: Citizens' Bldg.
LONDON: Queen Anne's Chambers, Westminster.

Edward A. Simmons, *President* L. B. Sherman, *Vice-President*
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Subscriptions, including the eight daily editions of the *Railway Age Gazette* published in June in connection with the annual conventions of the Master Car Builders' and American Railway Master Mechanics' Associations, payable in advance and postage free:

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| United States, Canada and Mexico | $2.00 a year |
| Foreign Countries (excepting daily editions) | 3.00 a year |
| Single Copy | 20 cents |

Entered at the Post Office at New York, N. Y., as mail matter of the second class.

**WE GUARANTEE, that of this issue 6,350 copies were printed; that of these 6,350 copies 4,917 were mailed to regular paid subscribers, 250 were provided for counter and news companies' sales, 230 were mailed to advertisers, exchanges and correspondents, and 953 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 25,900, an average of 5,180 copies a month.**

**The RAILWAY AGE GAZETTE, MECHANICAL EDITION and all other Simmons-Boardman publications are members of the Audit Bureau of Circulations.**

Statement of the ownership, management, etc., of the *Railway Age Gazette, Mechanical Edition* (including the *American Engineer*), published monthtly at New York, N. Y.:

Editor, Roy V. Wright, Woolworth Bldg., New York, N. Y.
Managing Editor, None.
Business Manager, None.
Publisher, Simmons-Boardman Publishing Co., Woolworth Bldg., New York, N. Y.
Owners, Simmons-Boardman Publishing Co., Woolworth Bldg., New York, N. Y.

STOCKHOLDERS:
Edward A. Simmons, New York. Roy V. Wright, New York.
Ida R. Simmons, New York. Elmer T. Howson, Chicago, Ill.
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BONDHOLDERS:
S. W. Dunning, New York. C. C. Newcomb, Brooklyn, N. Y.
Estate of Wm. H. Boardman, N. Y.

Simmons-Boardman Publishing Company,
By E. A. Simmons, President.

Sworn to and subscribed before Harry E. French, Notary Public for Kings County, N. Y. (No. 15), whose certificate is filed with the County Clerk of New York (No. 13), and whose commission expires March 30, 1916, on April 1, 1915.

Volume 89 May, 1915 Number 5

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**Government Inspection of Railway Equipment**

In but a few isolated cases do we find that the federal inspectors of cars or locomotives have treated the railways under their jurisdiction unfairly, and after these cases were brought to the attention of the chief inspectors a distinct improvement was noticed. So far, it has been shown that the government inspection bureaus aim to do the square thing, *but* they do, at the same time, demand that the roads co-operate with them and show them the same consideration. The roads that have done this have found it much to their advantage. The inspection laws should be interpreted in a broad sense and every effort should be made to comply with the "intent of the law," an expression frequently used by the inspectors, which is to promote safety.

Mechanical department officers from the top to the bottom should so conduct their work that the inspectors will have absolute confidence in them. It is far better to come to a definite understanding on the ground than to try to "put something over," as it were, after the inspector leaves the premises. If an agreement cannot be reached and an injustice has been done the mechanical men in charge should comply with the inspectors' demands and then take the matter up through their superiors with the chief government inspector.

**More Supervision Needed**

The already extensive territory of some of the division master mechanics on a certain trunk line has recently been increased, and this without the appointment of any extra assistants. We believe that in general such a move is wrong; there are very few roads which would not benefit by reducing the extent of the territory of division master mechanics, and in this particular instance, where each man has jurisdiction over a division extending from 700 miles to 1,000 miles, considerable of which is double track carrying a dense traffic, it is difficult to follow the reasoning of those responsible for the change. Probably it was made on the basis of the old-established idea which still seems prevalent on railways, that an officer, to give the company his best service, should be so burdened with work that he never has time to think of anything else and is always at least a week behind in his correspondence. It is seldom economical to reduce supervision; on the contrary, economical results are much more likely to be obtained from an increase in the supervising forces, provided care is taken to make the organization effective. An officer who is overloaded with work cannot keep in close touch with his subordinates, who are quick to realize this, and in consequence become slack in both their movements and their thinking. Cases of cutting down the number of foremen or master mechanics arise not infrequently, but we have yet to learn of such a move resulting in economy.

**Heat Treatment of Steel**

Great advances have been made in the science of heat treatment of steel during the past 15 or 20 years. These have been simultaneous with the development and increasing use of alloy steels, the utility of which depends largely upon the care exercised to properly control the heating during the operations intervening between the manufacture of the steel and its final application as a finished product. While a thorough knowledge of this science and the application of the most approved methods and latest appliances are not as essential in the railway shop as in some other industries, they should not be considered as unnecessary refinements. All railways are extensive users of tools, many of which are manufactured in their own shops, and carbon or alloy heat treated steels are now being used for such locomotive details as crank pins, piston rods, side rods, frames, axles and many small valve motion parts. It is true that the larger parts, such as rods, axles, etc., may be purchased ready to finish in the machine shop, thus avoiding the necessity of handling the material in the railway blacksmith shop. However, in order to take full advantage of heat treated material, the railway shop must be equipped to handle it. While there are many skilled operators working with the open forge and depending upon color indications for temperature control, we believe that present day demands upon material fully justify the application of more accurate methods. In an article on hardening tool steel appearing on another page of this issue the numerous variables in the hardening process are discussed, some interesting data being included. We wish to call especial attention to the author's conclusion: "To expect uniformly good results from a hardener whom you have not provided with adequate or suitable equipment is unreasonable. When the question of good equipment in the way of furnace, quenching mediums, pyrometers, etc., has been satisfactorily taken care of, your hardener still has plenty of variables to contend with, which are beyond his control."

**Dead Weight in Passenger Equipment**

Since the all-steel passenger train is now a matter of every day railway service, it is interesting to consider comparative figures as to the weights of wooden and steel cars. The day coach of wooden construction, built within the past ten or twelve years, averaged in dead weight per seated passenger, assuming the full seating capacity as occupied, about 1,000 lb.; a similar average for the steel day coach is about 1,500 lb., with a minimum of 1,225 lb. One of the most recent wooden coaches used on a certain road weighs 91,000 lb., which, with a seating capacity of 62 gives a dead weight of 1,470 lb. per passenger. This figure seems high, particularly when we consider that the standard steel coach of the same road has a dead weight per passenger of 1,360 lb. A slightly older wooden car, on this road, with a total weight of 70,000 lb. seated 64 passengers, which is 1,090 lb. dead weight per passenger.

A steel frame day coach, of which there are a large number in service, has a total weight of 120,000 lb., seating 70 passengers, with a dead weight per passenger of 1,710 lb., while a steel coach used on still another road weighs 142,000 lb., with a seating capacity of 84, giving a dead weight per passenger of 1,470 lb. But on the average, the cars of a passenger train are not fully occupied and it is enlightening to look into the matter of dead weight hauled under such conditions. Considering first an all-wooden train of ten or fifteen years ago, consisting of a baggage car weighing, with load, 75,000 lb., four day coaches weighing 75,000 lb. each, and five sleeping cars weighing 100,000 lb. each, we have a total dead weight in the ten car train of 875,000 lb. If we assume 45 passengers in each of the coaches, the seating capacity of each coach being 64, and 30 in each sleeping car, which should be a very liberal average, we have a total of 330 passengers, which gives a dead weight per passenger in the train of 2,650 lb. Considering, now, a similar all-steel train, the baggage car and load weighing 130,000 lb., four day coaches weighing 142,000 lb. each and five sleepers weighing 150,000 lb. each, we have a total weight in the train of 1,448,000 lb., an increase over the all-wood train of 573,000 lb. Assuming the same number of passengers in each sleeper, and about the same proportion of the seating space as occupied in the day coaches, we have 60 passengers in each coach, or a total for the train of 390. This gives a dead weight per passenger of 3,700 lb., or an increase over the wooden car train of 1,050 lb., or 31 per cent, per passenger.

As before stated the figures employed for the number of passengers are liberal; there are hundreds of trains operated daily in which such a large proportion of the seating capacity is seldom occupied, and many of the seats are occupied for short distances, while the entire train has to be hauled through between terminals. Moreover, if we consider the day coaches as replaced by club cars, buffet library cars and dining cars we have a very common condition and one which is still more expensive for the railroads. The traveling public demanded and received all-steel equipment in passenger trains. With the resultant conditions as indicated above, is it unreasonable to expect the same traveling public to pay increased passenger fares?

**Fashions in Locomotives**

Under the heading "Why Use a High Factor of Adhesion in Steam Locomotives?" a correspondent in the Railway Age Gazette of April 9, 1915, page 778 says, in part: "From the standpoint of utilizing the greatest possible portion of the total engine and tender loaded weight in developing tractive effort, the ideal locomotive is the one in which all such weight is carried on the driving wheels. Where truck wheels must be used the same reasoning dictates that the weight on drivers shall be as large a proportion of the locomotive weight as is practicable. It is, therefore, surprising to note in how many instances designers fail to make use of even the weight actually carried on the drivers in deciding on the factor of adhesion. For example, why should it be necessary to use a factor of adhesion of from 4.5 to 5.0 or over when it has been fully demonstrated by locomotives now in successful operation that a factor of 4.1 or 4.2 is sufficient?"

In looking over a list of recent locomotives it is surprising to find in how many cases the factor of adhesion is higher than would seem to be warranted. It is, of course, easy to understand that in the case of a high speed passenger locomotive the desire for high boiler capacity in conjunction with driving wheels of large diameter, forces the designer to use a higher factor of adhesion than he would otherwise adopt, while in some cases the factor is purposely made high to prevent slipping of the driving wheels under difficult operating conditions.

But a consideration of the amount of effective weight on drivers leads naturally to that of the relation between the adhesive weight and the total locomotive weight. The trailer truck, by facilitating the use of a deeper firebox and larger boiler has unquestionably been a most material factor in increasing locomotive capacity; but it is also true that it has added considerably to non-productive locomotive weight. Pacific and Mikado type locomotives have been the means of solving many operating problems and there are many roads on which they could not well be dispensed with. But the fact remains that these two types are "in fashion" and for that reason and no other conceivable one have they been placed in service on some roads which would be just as well, if not better off with locomotives of the Consolidation or Ten-wheel type. We hold no brief for the non-trailer locomotive, but we are firmly convinced that the craze for locomotives equipped with trailer trucks has been carried to extremes and that if the necessary designing were put into the Consolidation or the Ten-wheel type they would in many cases prove as economical and efficient as locomotives of the Mikado and Pacific types, if not more so. If boiler capacity is the main essential, and it is found that this cannot be obtained in passenger service without the use of a

trailer truck, there remains the Atlantic type whose possibilities have never yet been exhausted, at least for low grade roads. This has been amply demonstrated by one conspicuous design of Atlantic type locomotive produced within the last three years. The locomotive designer has made rapid progress in America during the past few years, and we believe that if the best interests of the railways are to be served, still more attention must be given to matters of design and less to following fashions.

**Shop Men or Railroad Men?**

We have always devoted a considerable portion of each issue to matters bearing upon shop and engine house practice; it is of great importance that means be developed for more easily and quickly accomplishing the different classes of work pertaining to locomotive and car repairs. Improvements in shop methods mean a reduction in shop expenses with a consequent reduction in the drain on the company's treasury, and it is our aim to publish descriptions of such devices and practices as will tend toward such economies. It seems pertinent, however, to remind some of our shop friends that the repair shop is, after all, only a means to an end; its function is to so repair equipment that it will be most effective in earning money for the company. Unfortunately, quite a number of shop trained men become narrow in their viewpoint and look at the equipment problem only from a repair shop standpoint. We by no means intend to belittle a man who perfects a device that will save $100 or $50, or even $1 in the repairing of a locomotive; the man who accomplishes such a saving is a valuable employee, but the man who can devise means of keeping a locomotive longer in service, that is, of increasing the number of miles run between shoppings, is much more valuable. The ideal condition, which, of course, is impossible of attainment, would be to keep locomotives and cars in continuous service. As equipment must needs undergo repairs, the company will be best served by the period between repairs being as long as possible and the time out of service undergoing repairs as short as possible. In general, it may be said that the shop man should strive toward repairing equipment as cheaply and at the same time as quickly and as well as possible, so that it will give a maximum mileage before again requiring shopping, cost a minimum for running repairs and give a maximum of economy in working, presupposing, of course, that it receives fair treatment while in service. This sounds like a pretty big order; it is, and no shop man can reasonably hope to even approximate such an accomplishment by looking at the problem from a shop standpoint alone. A shop man is a railroad man just as much as a division superintendent or a trainmaster or an engine house foreman is a railroad man, and he should look at his problems and attack them from a railroad standpoint.

**Pulverized Fuel for Locomotives**

The modern locomotive turns into useful work a considerably greater percentage of the heat units liberated in the burning of the coal than did the most efficient engine of ten years ago. The advances made in capacity and economical working have been the result of no single device or improvement, but rather of a combination of improvements. The superheater, the brick arch, the Mallet compound and the mechanical stoker are all factors in the increase of locomotive capacity; the three former have contributed extensively toward fuel and water economy, while improved design has undoubtedly helped in both economy and capacity. But the coal has still been burned in the same wasteful way on grates. With the successful completion of the experimental work connected with the use of pulverized fuel for steam generation in locomotives, a description of which will be found on another page, it should be of interest to consider briefly the possibilities of this method of combustion.

Enormous quantities of coal dust, slack, culm, etc., now go to waste at coal mines, in addition to which there are, principally west of the Mississippi river and in Canada, beds of sub-bituminous coal and lignite. Such fuels are obtainable at prices which are extremely low as compared with those now paid for coal suitable for burning on grates, but for various reasons they cannot be successfully burned in locomotive fireboxes. If, therefore, as is believed, such fuels can be successfully burned in a pulverized form, the effect on the cost of locomotive fuel, which at present constitutes about 25 per cent of the total cost of conducting transportation, can be readily seen. For example, some of the low grade western coals can be obtained at from 15 cents to 20 cents a ton, at the mine, but they cannot be utilized because of the amount of live sparks thrown from the locomotive stack, resulting in large fire losses along the right of way. In pulverized form, these same fuels can be placed on the locomotive tender at a total cost not to exceed from 50 cents to 75 cents a ton, and cinders, sparks and smoke are eliminated. Moreover, this development should be of great interest to coal operators, particularly in the West, as the large proportion of the coal that now goes to waste, but which costs just as much to mine as the salable grades, can be utilized for pulverization.

The smoke nuisance is the greatest argument of those who favor electrification, and it seems quite probable that pulverized fuel will be the means of postponing for many years some of the electrification schemes that have from time to time been urged, the capital that would have been necessary thus being available for other and more important betterment work. Aside from these important considerations, the application of pulverized fuel equipment to a locomotive is claimed to result in a direct saving of at least 20 per cent in fuel when the locomotive is working steam, as well as a saving due to the ability to extinguish the fire while standing on side tracks, at terminals and when drifting; there is a very considerable increase in the locomotive's sustained capacity, due to the reduction in back pressure and to the improved conditions of combustion; and the fireman has no heavy physical work, which should be the means of improving the standard of the men employed, with a corresponding effect on the standard of enginemen.

There must, of course, be considered the expense of drying and pulverizing machinery, but as the pulverized coal can be shipped to outlying stations in box or tank cars, it should not be necessary to equip more than a few terminals, and the savings effected in other ways should much more than offset this expense. For example, if lignite containing 9,000 B. t. u. can be pulverized ready for use at the mine tipple for 75 cents per ton, the saving through the use of this fuel as compared with coarse coal containing 13,500 B. t. u., costing $2.50 at the mine, is self-evident, even neglecting the greater effectiveness in the water evaporation. Considered from any standpoint, the successful use of pulverized fuel, if it meets present expectations, would seem to be the greatest single advance made in locomotive development in recent years.

## NEW BOOKS

*United States Safety Appliances.* Issued by the Master Car Builders' Association, Joseph W. Taylor, secretary, Chicago. 111 pages, 3⅞ in. by 7 in. Bound in brown press-board. Price 25 cents.

This book contains the orders issued by the Interstate Commerce Commission concerning safety appliances, and includes the rules and illustrations for their application and maintenance.

*Catechism of U. S. Safety Appliances.* By J. D. MacAlpine, Collinwood, Ohio. 42 pages, 2 plates, 3½ in. by 6 in. Bound in paper. Published by the author. Price, single copies, 15 cents; two copies, 25 cents; 12 copies, $1.50; 100 copies, $10.

This book covers the entire instructions of the Interstate Commerce Commission regarding safety appliances not only for freight cars but also for cabooses and passenger cars. It is arranged under headings for the different safety appliances, each

being considered separately. It is written in the question and answer form in order that those of limited education may more readily understand and comprehend the safety appliance rules.

*The Mechanical World Pocket Diary and Year Book.* 298 pages, net, 4 in. by 6 in. Bound in cloth. Published by Emmott & Company, Ltd., Manchester, England. Sold in the United States by The Norman Remington Company, 308 North Charles street, Baltimore, Md. Price 50 cents, postpaid.

This well known book contains a large amount of information covering a wide range of engineering subjects, all of which has been brought up to date in the new edition. Aside from the revision of material which the book formerly contained, a number of new sections have been added including some useful notes on gear cutting, a new section dealing with limit gages and another containing information relative to the strength of flat plates. A large number of tables are given, several of which are included for the first time this year, and many additional illustrations have been introduced. The present edition marks the twenty-eighth year of publication of the Pocket Diary and Year Book, and it has met with much favor because of its moderate price and the concise form in which the subject matter is arranged.

*The Mechanical World Electrical Pocket Book.* 224 pages, net, 4 in. by 6 in. Bound in cloth. Published by Emmott & Company, Ltd., Manchester, England. Sold in the United States by The Norman Remington Company, 308 North Charles street, Baltimore, Md. Price 50 cents, postpaid.

The electrical pocketbook is a companion volume of the well-known Mechanical World Pocket Diary and Year Book. The 1915 issue has been thoroughly revised and a number of new sections added. The section on electricity on shipboard has been rewritten and considerably extended, while additions have been made to the sections on electricity in coal mines, motor starters and others. A number of sections have been revised and condensed and as it now stands this little volume contains a large amount of up-to-date information covering the whole range of electrical engineering which should be especially useful to those in charge of electrical plants and machinery. Aside from the engineering information the book contains a number of mathematical tables and also includes a conveniently arranged diary. It is well indexed and its convenient size and low price commends it to those who desire a ready source of general information on electrical subjects.

*Universal Safety Standards, Machine Shop and Foundry.* By Carl M. Hansen, consulting safety engineer. Illustrated and indexed. 312 pages, 5 in. by 7½ in. Bound in leather. Published by the Universal Safety Standards Publishing Company, 12th and Race streets, Philadelphia, Pa. Price $3.

This is the second edition of this book, which has been revised and enlarged. It is intended as a reference book of rules, drawings, tables, formulas and suggestions on safety devices and protection for machines in the machine shop and the foundry. It was compiled under the direction of and approved by the New York Workmen's Compensation Bureau. The book is classified into four parts, general, machine shop, foundry and rules and practices. Each division touches practically all cases that arise under that classification. The book is confined to the conservation of life and limb rather than the conservation of property, making it a valuable book for employers of labor. It gives a collection of conditions ordinarily found in machine shops and foundries, and indicates the proper safeguards to apply, treating the conditions with plain, clearly worded, brief specifications and illustrating these specifications with drawings. Conditions in the construction of the plant are taken up, and the product followed from the receiving department to the shipping room, showing how in each instance safety measures may be applied. The illustrations are particularly good, machines and buildings being printed in black and white, while the safety devices are printed in color which makes them stand out very clearly.

# COMMUNICATIONS

## STRESSES IN SIDE RODS

Altoona, Pa.

To the Editor:

In the article on Reciprocating and Revolving Parts, pages 109 to 115, issue of March, 1915, there is a statement that the stress in the front and back stub eye of Pennsylvania Railroad rods is 26,500 lb. per sq. in. for the Atlantic type, and 31,700 lb. per sq. in. for the Pacific type. If the stresses in the rods ran this high the rods would not last a week. It is quite apparent that in determining this bending stress the author used the wrong method.

Referring to the eye of the rod, shown in Fig. 12, page 115: It will be noted that the inside diameter of the eye is 8 in., and the outside diameter 11 in. The bearing consists of a solid brass bushing, 1 in. thick, forced into the rod by hydraulic pressure. The circular shape of the rod eye cannot be changed without permanently compressing the bushing. There are three conditions to be considered. The pressure with which the bushing is put on may be too high. In that case the limit of the stress in the eye of the rod must be based on the elastic compressive strength of the bushing, and, with this as a basis, the bursting pressure of the eye, considered as a shell with pressure inside, must be determined. On this basis the stress is somewhat less than 12,500 lb. per sq. in.

The normal condition is when the bursting effect from the bushing is equal to the effect from tension on the rod, in which case the stress in the fibres on the circumference of the 8-in circle is 8,500 lb. per sq. in., and that on the circumference of the 11-in. circle is 5,000 lb. per sq. in.

The third condition covers a loose bushing, in which case the maximum stress is on the outer fibre, and may reach the value of nearly 10,500 lb. per sq. in.

As a matter of fact, when rods become defective after they have been in service, the breakages seldom, if ever, occur on the horizontal center line of the eye; they usually occur through the oil cup.

The author of the article also makes the statement that there is no really satisfactory formula for the design of pistons. As a matter of information, the writer begs to refer to an article by John Kraft, translated by J. Rennie, on page 248 of the Minutes of Proceedings of the Institution of Civil Engineers, Volume CXXVII, published in 1897.

W. F. Kiesel, Jr.,
Assistant Mechanical Engineer, Pennsylvania Railroad.

[Editor's Note.—The author of the article did not intend to convey the impression that the stresses given were actual. They are empirical, the idea being that if by a certain formula the stress at any particular section does not exceed a predetermined amount the rod is safe. The stresses of 26,500 lb. and 31,700 lb., referred to above, are not actual stresses; they are simply comparative figures derived from using a certain empirical formula that has proved its value by many years' practical use.]

Qualities of Magnet Steel.—In a paper presented to the English Institution of Automobile Engineers it was pointed out that while permanent magnet steel usually contains tungsten, the process of hardening it is one that requires great knowledge and care, the magnets being always very hard but not necessarily glass hard. If a long and short magnet are made of the same steel, the short one must be rather harder than the long one to get the best results out of each. The two qualities required in a magnet are high magnetization and permanence. The great bulk are small and for scientific instruments, but must possess as nearly absolute permanency as possible and need not be very strong. Magnets for a magneto, however, are large and therefore more difficult to harden uniformly. They must be as powerful as possible and reasonably permanent.—*American Machinist.*

# PULVERIZED FUEL FOR LOCOMOTIVES

## Tests Conducted Under Severe Operating Conditions Have Proved Satisfactory; Future Possibilities

The use of pulverized coal for heat-producing purposes is not new, this fuel having been extensively used for many years in cement and metallurgical furnaces, but while experiments have from time to time been conducted with a view to its use in the generation of steam, they were never developed to a practical and commercial conclusion.

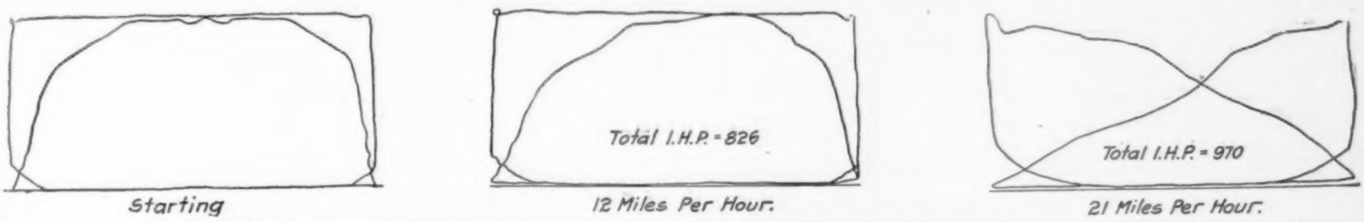
There are many reasons why a successful application of a means of burning pulverized fuel in locomotive fireboxes should be looked upon favorably. Such combustion is smokeless and there are no cinders or sparks thrown from the stack. The first of these items would bring the use of pulverized coal into careful consideration in congested terminal districts where public opinion is forcing the railways towards expensive electrification projects, while the second shows its value in the operation of steam locomotives through forests and other regions where fires are easily set. Furthermore, with the rapid inroads which are being made in the more superior qualities and grades of fuel supply of the United States, and, in fact, of the world, the cost of coal is rapidly increasing. With the application of pulverized coal burning apparatus, use can be made of the dust and refuse from mines as well as peat, petroleum coke, coke brieze, lignite and other low grade coals which are under present conditions unsatisfactory for steam production in locomotives.

To produce the best results as regards complete combustion and the least trouble from ash and slag, pulverized coal should contain not more than 1 per cent moisture and be of a uniform fineness, so that not less than 95 per cent will pass through a 100 mesh and not less than from 80 to 85 per cent through a 200 mesh screen. Coal must, of course, be dried either before grinding it or when burning, this being an item of expense that is necessarily present regardless of whether the coal is burned on grates or in suspension in the powdered form. When coal which is not dry is fed into a furnace the moisture is evaporated, which means that an added quantity of coal must be burned to maintain the temperature, the latter being reduced about 72 deg. F. for each one per cent of moisture entrained. As this cannot be overcome by feeding additional fuel with the same percentage of moisture, the loss of heat is about two per cent for each one per cent of moisture, this loss being further increased when applied to the usable heat above the temperature of the escaping smokebox gases. If the coal is dried before grinding, however, the cost for drying will be almost saved because of the decreased power required for pulverization and also because of the improved combustion resulting from the greater degree of fineness obtained in the dried as compared with the moist coal.

The cost for preparing pulverized coal varies with the cost of the coarse coal and with the moisture content. However, from data obtained during the past 10 years, assuming the cost of the coal at from $1 to $2 a ton, the total cost for preparation will vary from 25 cents to 50 cents in the case of a plant having a capacity of two tons (of 2,000 lb.) per hour to a cost of 10 cents to 20 cents in a plant of a capacity of 25 tons per hour. The amount of fuel required for drying the coal averages from one to two per cent of the coal dried. It will, of course, be necessary in railroad work to equip the existing principal coaling stations with machinery for crushing, grinding, drying and conveying the coal to a suitable storage plant as well as to the locomotive tenders.

The work of developing equipment for burning pulverized coal in steam locomotives has been carried out during the past year and a half and the results have now assumed a final and definite form, so that it is possible to give in what follows a general idea of what has been accomplished. The equipment referred to in this article has been developed by the Locomotive Pulverized Fuel Company, 30 Church street, New York, and while it is not possible to describe it at present in detail, it is expected that a more detailed description of the apparatus will be available at a later date. In order to determine the commercial practicability of the appliances which have been developed, application was made to a ten-wheel locomotive of about 31,000 lb. tractive effort, 200 lb. working steam pressure, 22 in. by 26 in. cylinders, 69 in. diameter driving wheels, 55 sq. ft. of grate area and equipped with a Schmidt superheater.

The experimental work has been carried out on this locomotive almost continuously since early in June, 1914, on a ruling grade from 6½ to 8 miles long and also on a district of 92 miles. Some of the indicator diagrams obtained are shown below for the purpose of illustrating the relatively low cylinder back pressure. As originally built the locomotive had an exhaust nozzle 5 in. in diameter, this being approximately 19.6 sq. in. in area. The nozzle used with the pulverized coal apparatus was rectangular, 5½ in. by 8 in., giving an area of 44 sq. in. With the original nozzle the back pressure at speeds of from 15 to 20 miles an hour was from 8 lb. to 11 lb., while with the rectangular nozzle the back pressure at the same speeds was from 1 lb. to 3 lb. The reduction in back pressure much more than compensated for the steam consumption of the turbo-generator as well as for any use made of the steam blower while at the same time increasing the locomotive's capacity and reducing wear and tear on the machinery. The turbo-generator, which is of 10 kw. capacity, is placed at the forward end of the locomotive in front of the smokebox or in any other convenient location, and supplies current for two motors driving the conveying and blowing machinery, located on the front of the tender, which carries the coal into the firebox.




**Indicator Diagrams Taken on a Locomotive Burning Pulverized Coal, Showing Low Back Pressure**

The smokebox temperatures obtained were from 425 deg. to 490 deg. F., while the corresponding firebox temperatures ranged from 2,600 deg. to 2,850 deg. F. On no occasion did the locomotive stall because of insufficient steam; in fact, the safety valves were open at all times when the engine stalled. The tests were all conducted under the most severe conditions possible, namely, cold weather, low volatile coal, coarse pulverization of the coal, full tonnage rating and in many instances more than full rating.

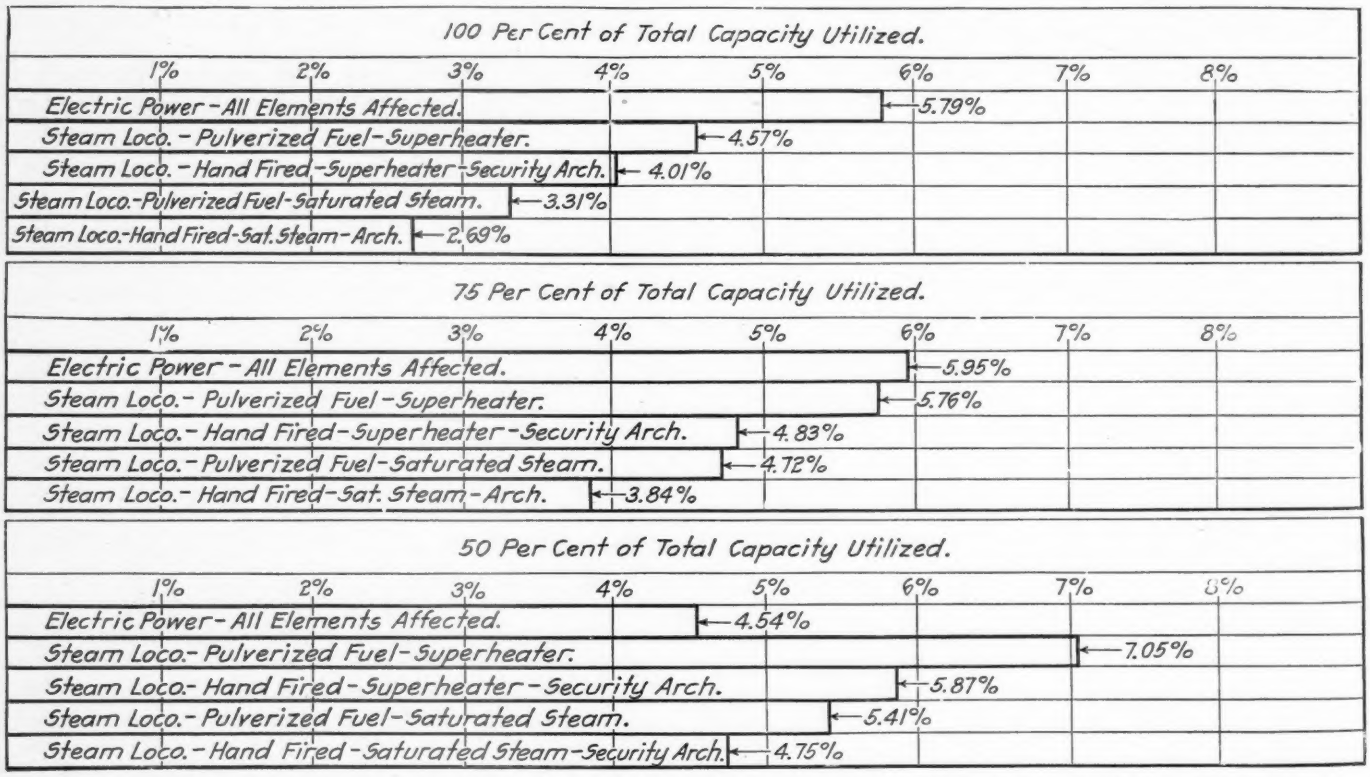
The tonnage hauled on the maximum ruling grade ranged from the regular summer rating to 15 per cent greater than the summer rating in freezing weather and the locomotive accelerated

the train in numerous instances on the ruling grade to speeds of from 20 to 25 miles per hour.

The coal used in these tests was ordinary bituminous coal and contained from 21 to 26 per cent volatile matter and about 15 per cent of non-combustible. When fed at the rate of 2,500 lb. to 4,000 lb. per hour the various smokebox gas analyses showed an average of less than 1 per cent of free oxygen or carbon monoxide and from 11 per cent to 14 per cent of carbon dioxide. The evaporation obtained ranged from 9½ lb. to 12¾ lb. of water per pound of coal from and at 212 deg. F.

The coarsest grade of the coal ran 39.6 per cent through a 200 mesh screen, 20 per cent on a 200 mesh screen and 40.4 per cent on a 100 mesh screen. The finest grade ran 66½ per cent through a 200 mesh screen, 95½ per cent through a 100 mesh screen and 98½ per cent through an 80 mesh screen. According to statements made before the American Society of Mechanical Engineers, the most satisfactory results are obtainable from coal which will run from 80 to 82 per cent through a 200 mesh screen and 95 per cent through a 100 mesh screen. Analyses of the coal used showed that it ranged from .67 per cent moisture, 65.16 per cent fixed carbon, 21.63 per cent volatile matter, and 13.12 per cent ash with 13,671 B.t.u. per lb., to .88 per cent moisture, 25.67 per cent volatile matter, 63.05 per cent fixed carbon and 10.4 per cent ash with 13,912 B.t.u. per lb. In the statements before the American Society of Mechanical Engineers, referred to above, 30 per cent volatile matter was generally mentioned as a minimum for the best results. The capacity of each combination conveyor, feeder and mixer ranged from about 250 lb. of coal per hour at the lowest speed of 23 revolutions per minute of the feed screw to about 1,600 lb. of coal per hour at a speed of 133 revolutions per minute, this capacity being susceptible to increase or decrease as the demands of the locomotive may require.

The locomotive steamed satisfactorily throughout the tests; in fact, more steam was produced than was required, and there was no smoke. The exhaust steam assumed at times a slightly grayish color, but at no time was there any evidence of dust or ashes, and no cinders or sparks were emitted. There is a saving of from 15 per cent to 25 per cent in coal consumed as compared with ordinary hand firing, but it has so far been impossible to compute this definitely. No change is necessary in the boiler of the locomotive other than to remove all of the smokebox draft appliances and the grate and ashpan equipment. The pulverized coal blower and combination conveyors, feeders and mixers are attached to the front of the tender coal space and the coal tanks can be applied to many tenders as at present constructed. This coal container is so arranged as to be usable for either pulverized coal or fuel oil, and the entire equipment can be readily changed without extra cost for burning fuel oil. The Security brick arch is used in the firebox and special brick work is used below the arch and mud ring. The refuse runs down into a collection pan below the firebox in the form of a slag, which when hardened is of a glassy nature and is very easily broken and falls out when the pan is opened. About 2.5 per cent of the weight of the coal fired when it contains 15 per cent of non-combustible is deposited in the slag pan in the form of concentrated slag as compared with about 15 per cent accumulation in the ashpan when coal is burned on the grates. This is due largely to the slag containing no combustible whatever, whereas ordinary ashpan residuum usually contains considerable combustible.




**Comparison of Thermal Efficiency of Electric and Steam Motive Power, Showing Percentage of Power Delivered at the Rail for 100 Per Cent B. T. U. in the Coal**

The cost for preparing pulverized coal should, it is believed be more than offset by the difference in mine cost of the mine refuse and sweepings as well as lignite and other inferior grades of coal, as compared with fuel that must be used when burning on grates. Considerable savings in the matters of inspection, maintenance and operation are also indicated through the complete elimination of grates, ashpans, smokebox netting, handhole plates and spark hoppers, firing tools and squirt hose, as well as prevention of loss of fuel from the open coal space. There is very little collection of ash in the tubes and terminal and intermediate delays due to cleaning and dumping fires and blowing out tubes are also avoided and the facilities for performing such work are practically eliminated. There being no cinders, cutting of superheater elements, etc., is eliminated. The cost of building fires is also reduced to a minimum, as no special fuel or labor is required for this purpose, it being only necessary to light a piece of oily waste or other refuse material to start the

fire. The fire can be extinguished when the locomotive is on sidings and at terminals, or when drifting, thus saving fuel, and it will restart from the heat of the furnace within an hour without relighting. When building fires, 200 lb. steam pressure can be obtained from water at 40 deg. F. in 45 or 50 min. The physical requirements of firing a locomotive are reduced to those of firing with oil, while at the same time a more constant firebox temperature and more uniform steam pressure are claimed to be available under varying operating conditions. Relieving the fireman of the arduous physical exertion of hand firing should result in an improved standard of applicants for this position, making it correspondingly easier to develop higher class enginemen.

The following figures should be of interest as bearing on the cost of electrification as compared with that of equipping an average modern type of locomotive for burning pulverized fuel: Cost of a new Consolidation type locomotive of 50,000 lb. tractive effort, equipped with superheater and

| | |
|---|---|
| (a) for handfiring and burning coal on grates, approximately | $22,000 |
| (b) for burning fuel oil in suspension, approximately | 22,750 |
| (c) for mechanically stoking and burning coal on grates, approximately | 24,000 |
| (d) for automatically stoking and burning pulverized coal, lignite, peat or fuel oil in suspension, approximately | 26,500 |
| (e) cost of electric locomotive, approximately | 50,000 |

Throughout the entire series of tests no trouble whatever was experienced with explosions, no tendency was found for any explosion to take place and there was no blow-back and noise such as occurs where fuel oil is used. In general, the firing of pulverized coal is conducted by means of one of two methods, one being known as the short flame method and the other as the long flame method. In the application to locomotives a combination of the two methods has been employed.

One of the illustrations shows a diagram of the thermal efficiency of electric and steam motive power under different conditions. The top portion of this diagram, in which 100 per cent of the total maximum capacity or load factor is assumed as utilized, is obviously an ideal condition and one which never obtains in actual service, the condition in which 50 per cent is utilized being more nearly the average for steam road operation. With electrical operation this load factor seldom exceeds 35 per cent. It will be noticed that under these conditions pulverized coal shows up as extremely advantageous. These figures do not consider any emergency power plant or storage battery equipment for electrical operation.

## RECIPROCATING AND REVOLVING PARTS†

BY H. A. F. CAMPBELL*

PART II—ALLOY AND HEAT-TREATED CARBON STEEL

Thirty years ago it was a difficult matter to convince engineers that steel was better than wrought iron for axles, pins or connecting rods, yet today a wrought iron axle or pin is hard to find. In the same way many engineers are now uncertain as to the advisability of using either heat-treated carbon steel or heat-treated alloy steel.

If we wish a material to resist shock loads, alternating and repeated stresses, we should choose one possessing high elastic limit and good elongation; and in the case of a forging, the work should be particularly well done so that the material is freed from all internal forging strains. In alloy steels, when heat-treated, the elastic limit can be very greatly increased in relation to the ultimate strength, but without sacrificing ductility. No two pieces of steel, however, are alike in their chemical composition and even if they closely approach each other in this respect, the difference in mechanical treatment during their manufacture causes them to possess widely different physical properties. The method of forging, that is, the size of the original ingot in relation to the size of the final forging, the amount of work put upon this ingot, and the rate of reducing the metal, all have a most important bearing upon the final physical quality of the steel. When an alloy steel is used, the care which is put into the forging process helps greatly in obtaining desirable physical qualities. The alloy of nickel or chrome or vanadium makes a marked difference in the structure of the steel, but just as much is it the time and care that has been put into the forging.

To date the use of alloy steel for locomotive piston rods, connecting rods, stub straps or wrist pins has been limited; chrome-vanadium steel has been used for a few sets of these parts. But advantage has not been taken of the opportunity to reduce the weight by working the steel up to its full capacity as regards strength. Nickel-chrome steel has been used in only two sets of these parts in recent years; details of their design have already been given in this article. In this case full advantage was taken of the increased strength of the steel to reduce the weight. Ten years ago some nickel-chrome steel crank axles were made in this country. These crank axles are running today, having made over 1,000,000 engine miles. This metal has proved to be a good bearing surface for the crank pins. Chrome-vanadium and nickel-chrome crank pins have shown excellent wearing qualities.

Table XII gives the chemical and physical properties that should be obtained from .45 carbon steel, .45 carbon steel heat-treated, chrome-vanadium steel heat-treated and nickel-chrome steel heat-treated.

In many cases fractures of rods are due to failure on the compression side of the member and not to failures on the tension side. That being the case, it is very important to know what is the compressive strength of these steels. Many tests of the tensile strength are available, but there are very few tests of the compressive strength. The few tests that have been made on such sections as apply to the parts under consideration have shown that in compression members, when $\frac{l}{\rho}$ does not exceed 150, the ultimate compressive strength is about equal to, or a little less than, the tensile elastic limit. This relation has been discussed by Prof. Lanza in the proceedings of the American Society for Testing Materials, Vol. VII, 1907, page 281, and seems to be pretty well established. We have, then, a means of determining approximately the ultimate compressive strength. The writer does not know of any compressive tests on full size parts made of chrome-vanadium or nickel-chrome steel. When such tests are made the results should follow closely those given in table XII. There is no reason why they should not, but until such time it would seem conservative to consider the ultimate compressive strength as 90 per cent of the tensile elastic limit. This means that alloy steel, if considered from the compressive side alone, is about 45 per cent stronger than regular

TABLE XII.—PROPERTIES OF VARIOUS STEELS

| Kind of steel | Carbon | Chrome | Nickel | Vanadium | Ultimate strength, lb. per sq. in. Tension | Compression | Limit, elastic | Elongation in 2 in., per cent |
|---|---|---|---|---|---|---|---|---|
| O. H. carbon | .35 to .45 | ..... | ..... | ..... | 75,000 | 32,000 | 35,000 | 20 |
| O. H. carbon, heat-treated | .35 to .45 | ..... | ..... | ..... | 85,000 | 46,000 | 50,000 | 20 |
| Chrome-vanadium, heat-treated | .28 to .42 | .75 to 1¼ | ..... | Not under .15 | 100,000 | 60,000 | 65,000 | 20 |
| Nickel-chrome, heat-treated | .35 to .40 | .25 to .28 | 1¼ | ..... | 100,000 | 60,000 | 65,000 | 20 |

*Baldwin Locomotive Works, Philadelphia, Pa.
†Part I appeared in the March and April, 1915, issues, pages 109 and 163.

non-heat-treated .45 carbon steel, or about 20 per cent stronger than heat-treated .65 carbon steel.

At the December, 1914, meeting of the American Society of Mechanical Engineers, C. D. Young, engineer of tests of the Pennsylvania Railroad, and H. V. Wille, of the Baldwin Locomotive Works, discussed heat-treated carbon and alloy steel and high carbon steel for locomotive parts. A table showing the ultimate strength and the allowable working stresses for these different steels was given.* Mr. Wille brought out an important point, namely, that we have not yet obtained all that is possible from carbon steel. His idea was that if a higher carbon steel were used, say .65 carbon oil-tempered, with a slightly reduced elongation, say 15 per cent, results equally as good as those from alloy steels could be obtained.

It is to be hoped that more tests on full-sized sections of these different steels can be made. The results would be of great value and would form a basis for further study of the relative merits of the steels now so much under discussion.

## EDUCATING ENGINEMEN IN SMOKE ELIMINATION†

The education of enginemen in the elimination of smoke must by no means be restricted to the firemen. The engineer is in direct control of the fireman while they are on the engine and unless he too is instructed, interested, and his co-operation obtained, the effect of the fireman's instruction will be materially lessened. Most of the engineers were educated in the art of firing at a time when it was thought that a locomotive must make smoke in order to get steam, and this idea must be removed from their minds.

The principal factor to be considered in the matter of instruction is the instructor. He should be one who has not only had a thorough practical experience, but a sufficient technical education concerning the process of combustion. In addition he should be a man who knows how to handle men, and at the same time, be capable of so imparting his knowledge to them that they will become thoroughly interested in their work. A road foreman of engines is, perhaps, one of the best men for this work. One of the greatest difficulties the instructor will meet in his endeavor to establish new rules and educate enginemen along the lines of proper combustion, will be in making them realize the fact that in order to utilize as nearly as possible all the heat contained in the coal, a locomotive must be fired in such a manner as to consume the hydrocarbon gases of the fuel as well as the coke or fixed carbon. In other words, if they are fired with a minimum amount of smoke, a maximum of economy will obtain.

The locomotive fireman in attempting to obtain smokeless combustion has a much more difficult problem than the fireman of a stationary plant, for the latter has constant and stable conditions to deal with, while the former is required to furnish steam for maximum and minimum power requirements within small intervals of time. In this respect the engineer, by informing the fireman as to his intended operations, can minimize his difficulty.

An applicant for the position of locomotive fireman should be at least 21 years of age, have a common school education, good habits, and be accustomed to hard labor. When first employed he should be instructed on combustion and provided with literature on this subject so written that it can be easily understood. He should be instructed on the rules pertaining to the movement of trains, which can be most successfully accomplished by requiring the student fireman to ride with a competent engine crew. Then the road foreman, or the traveling fireman, should take him in hand and demonstrate by actual practice the advantages of complete and smokeless combustion, at the same time explaining the process of combustion as much as possible while on the road. The operation of smoke consumers used should be thoroughly explained and their effect demonstrated by actual operation so that it may be clearly shown why it is necessary to admit air above the fire. The student fireman should also be instructed as far as possible in the judging of the temperature of the firebox by the appearance of the fire; also, considerable benefit may be obtained by giving lectures to the enginemen on combustion, showing stereopticon views which will not only interest the men, but give them something definite to keep in their minds. Above all, both the road foreman of engines and the engineer should co-operate with the fireman so that he will realize that interest is being taken in his welfare.

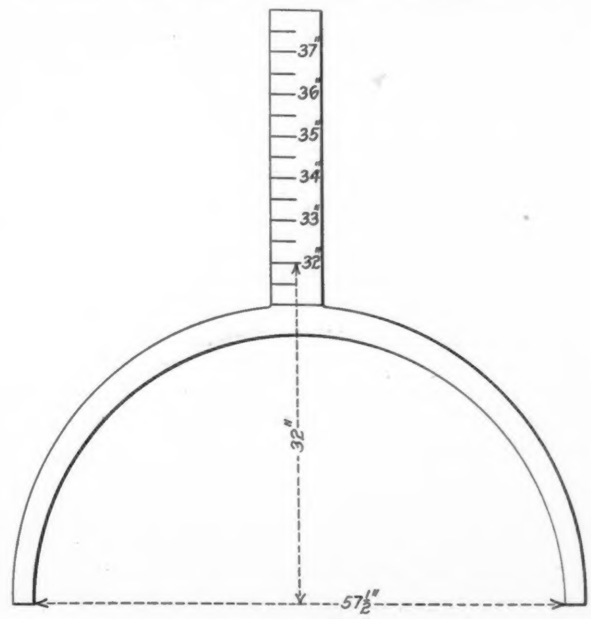
*See *Railway Age Gazette, Mechanical Edition*, January, 1915, page 13.

†From a paper presented at the ninth annual convention of the International Association for the Prevention of Smoke.

## GAGE FOR PILOT COUPLER

BY H. C. SPICER
Gang Foreman, Atlantic Coast Line, Waycross, Ga.

A coupler gage which is very convenient for gaging the height of pilot couplers is shown in the accompanying drawing. The gage may be made from 1/4 in. or 3/8 in. by 1 in. common iron, and the stem graduated in half-inches beginning at 32 in. and



Device for Gaging the Height of Pilot Couplers

continuing upward. The circular shape of the base will permit of its being used over the nose of the pilot.

Cole-Scoville Truck.—In the description of a 2-10-2 type locomotive recently built by the Baldwin Locomotive Works for the Erie Railroad, which appeared on page 158 of our April issue, it was stated that the locomotive was equipped with the Cole trailing truck. Our attention has been called to the fact that the correct name of this truck, which is of the outside bearing type with a hinged or floating yoke, is the Cole-Scoville truck.

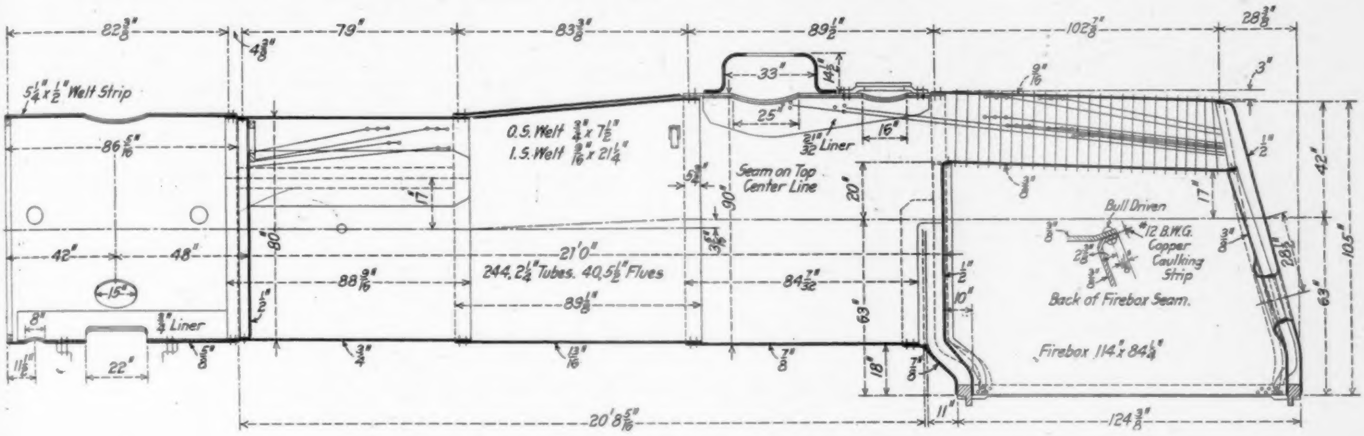
Machining Cast Iron.—To overcome tool trouble in machining small gray-iron castings, an annealing process is often effective. A process claimed to accomplish excellent results is to pack the castings in cast-iron chips (with some broken charcoal to make a reducing atmosphere to prevent scaling) in ordinary annealing boxes. The castings are then heated to a good red heat and kept there for several hours, the time varying with the size of the pieces. Slow cooling is then permitted to take place.—*American Machinist.*

# SANTA FE PACIFIC TYPE LOCOMOTIVE

**Single Expansion Engine Equipped for Burning Fuel Oil; Maximum Tractive Effort 41,000 lb.**

The Atchison, Topeka & Santa Fe received from the Baldwin Locomotive Works a simple Pacific type locomotive, which now forms a part of the exhibit of the builders at the Panama-Pacific International Exposition at San Francisco, Cal. It is the first single expansion* engine to be built for passenger service on the Santa Fe system in some years.

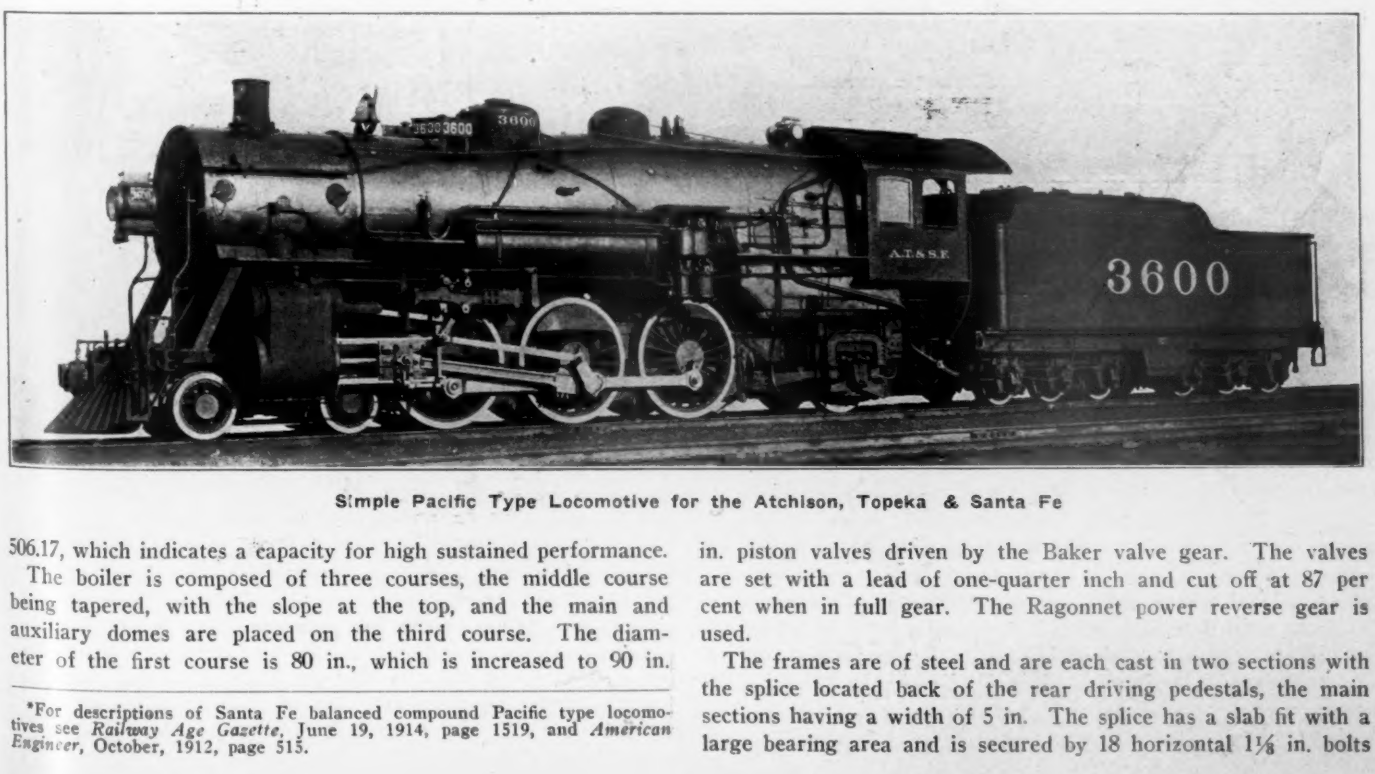
The locomotive is designed to develop the maximum possible capacity within a limiting rail load of 58,000 lb. per pair at the third course. A circular opening 16 in. in diameter under the auxiliary dome permits entrance to the boiler without dismantling the standpipe and throttle fittings in the main dome. The boiler is equipped for oil burning, but the staybolts are so located that arch tubes may subsequently be applied should it be necessary to fit the locomotive for coal burning service. The inside firebox door sheet is flanged outward, bringing the rivet heads in the water space, and the seam is closed




**Boiler of the Santa Fe Simple Pacific Type Locomotive**

of driving wheels, and the total weight on the driving wheels of 172,500 lb. closely approaches this limit. The design was prepared jointly by the railway company and the builder and, as in all recent Santa Fe locomotives, the details have been designed to interchange as far as practicable with those of locomotives already in service. The new locomotive develops a tractive effort of 41,000 lb., with a factor of adhesion of 4.2, and has a total equivalent heating surface of 5,913 sq. ft. The ratio of cylinder tractive effort to equivalent heating surface is with a copper calking strip. The O'Connor fire door flange is used and the door seam is welded by the autogenous process. Flexible staybolts are used in the breakage zones in the throat, sides and back as well as in the first four rows of crown stays. The boiler is equipped with a Schmidt superheater of 40 elements with a superheating surface of 980 sq. ft., and among the special fittings is included the Chambers throttle.

The cylinder castings are strongly built with liberal steam and exhaust passages. The steam distribution is controlled by 16-



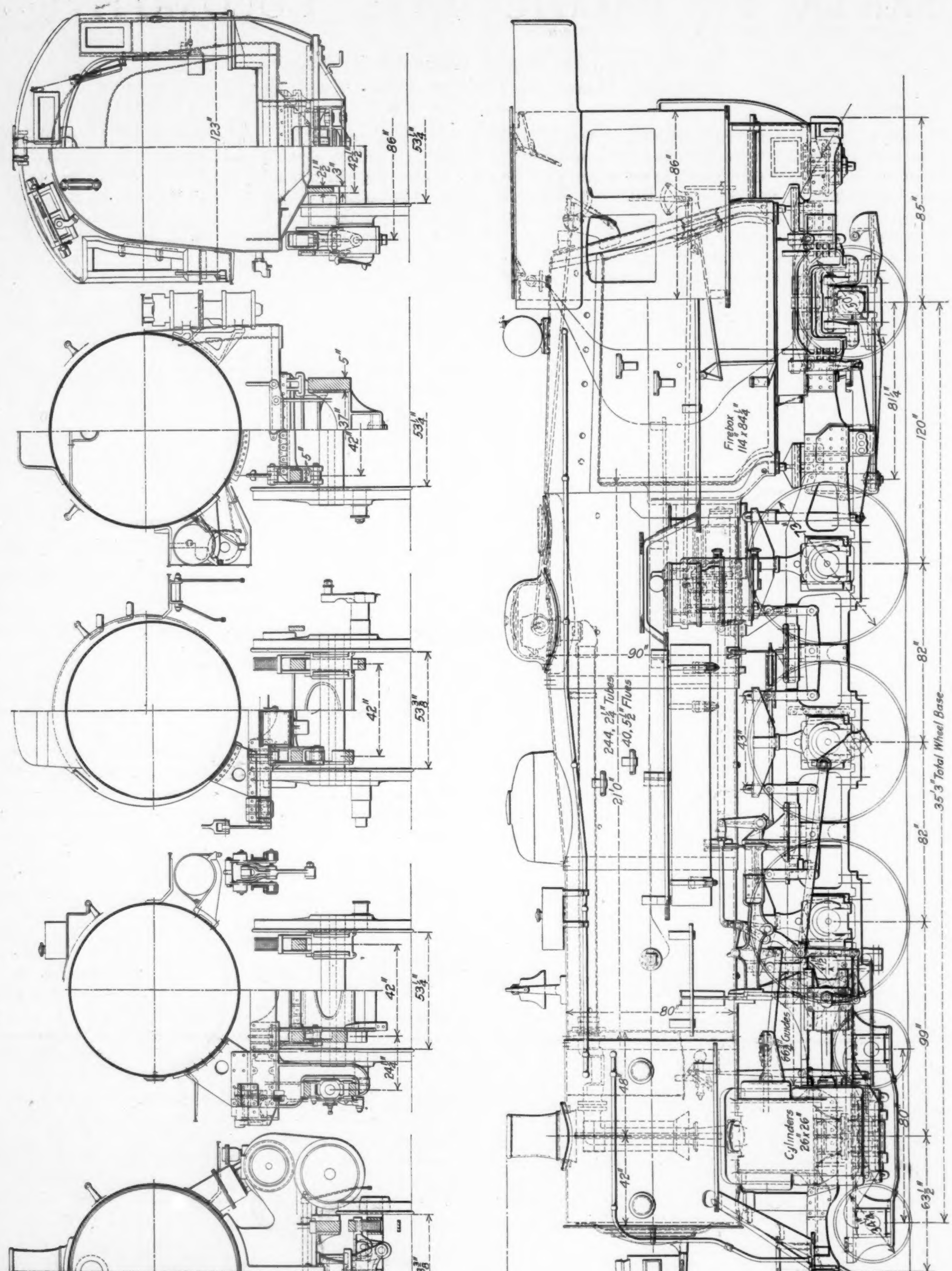

**Simple Pacific Type Locomotive for the Atchison, Topeka & Santa Fe**

506.17, which indicates a capacity for high sustained performance.

The boiler is composed of three courses, the middle course being tapered, with the slope at the top, and the main and auxiliary domes are placed on the third course. The diameter of the first course is 80 in., which is increased to 90 in. in. piston valves driven by the Baker valve gear. The valves are set with a lead of one-quarter inch and cut off at 87 per cent when in full gear. The Ragonnet power reverse gear is used.

The frames are of steel and are each cast in two sections with the splice located back of the rear driving pedestals, the main sections having a width of 5 in. The splice has a slab fit with a large bearing area and is secured by 18 horizontal 1⅛ in. bolts

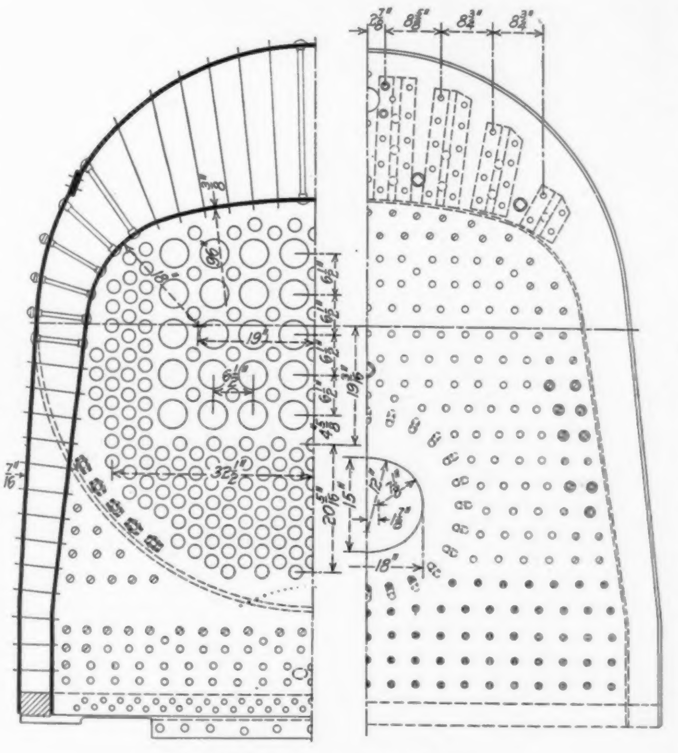
*For descriptions of Santa Fe balanced compound Pacific type locomotives see *Railway Age Gazette*, June 19, 1914, page 1519, and *American Engineer*, October, 1912, page 515.




Elevation and Cross Sections of Santa Fe Simple Pacific Type Locomotive

and a pair of vertical keys. A substantial system of transverse frame bracing is applied. The guide bearer brace, which is a large steel casting, extends the full depth of the leading driving pedestals, serving as a fulcrum for the driving-brake shaft, and the valve motion bearer, which is located midway between the front and main driving pedestals, has a long bearing on the upper frame rail. A similar brace supporting a waist sheet is placed between the main and rear driving pedestals. A deep brace is also applied at the main pedestal and the frames are braced at the splices between the main and rear sections by a large casting which supports the front end of the firebox and carries the trailer truck radius bar pin.

The driving boxes are cast steel and are fitted with brass hub faces which bear against steel wheel centers. The shoe and wedge faces of the boxes are also lined with brass, while the shoes and wedges are cast iron. Flange oilers are applied to the main driving wheels. The trailer track is of the Rushton type with outside journals, a design that has been applied to a large number of locomotives built for the Santa Fe System.



**Cross Sections of the Boiler**

The truck frame is composed entirely of steel castings and the swing links are of the three-point suspension type.

The tender has a water capacity of 10,000 gal., and carries 3,300 gal. of oil. The trucks are of the six-wheel Commonwealth type; this type is now in use under a large number of high capacity tenders in passenger service on the Santa Fe.

The principal dimensions and data are as follows:

*General Data*

| | |
|---|---|
| Gage | 4 ft. 8½ in. |
| Service | Passenger |
| Fuel | Oil |
| Tractive effort | 41,000 lb. |
| Weight in working order | 288,700 lb. |
| Weight on drivers | 172,550 lb. |
| Weight on leading truck | 59,950 lb. |
| Weight on trailing truck | 56,200 lb. |
| Weight of engine and tender in working order | 506,000 lb. |
| Wheel base, driving | 13 ft. 8 in. |
| Wheel base, total | 35 ft. 3 in. |
| Wheel base, engine and tender | 71 ft. 5¼ in. |

*Ratios*

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.21 |
| Total weight ÷ tractive effort | 7.04 |
| Tractive effort × diam. drivers ÷ equivalent heating surface* | 506.17 |
| Equivalent heating surface* ÷ grate area | 88.65 |
| Firebox heating surface ÷ equivalent heating surface,* per cent | 3.92 |
| Weight on drivers ÷ equivalent heating surface* | 29.18 |
| Total weight ÷ equivalent heating surface* | 48.82 |
| Volume both cylinders | 15.98 cu. ft. |
| Equivalent heating surface* ÷ vol. cylinders | 370.02 |
| Grate area ÷ vol. cylinders | 4.17 |

*Cylinders.*

| | |
|---|---|
| Kind | Simple |
| Diameter and stroke | 26 in. by 26 in. |

*Valves*

| | |
|---|---|
| Kind | Piston |
| Diameter | 16 in. |
| Lead | ¼ in. |

*Wheels*

| | |
|---|---|
| Driving, diameter over tires | 73 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, main, diameter and length | 11 in. by 13 in. |
| Driving journals, others, diameter and length | 11 in. by 13 in. |
| Engine truck wheels, diameter | 34¼ in. |
| Engine truck, journals | 7 in. by 12 in. |
| Trailing truck wheels, diameter | 50 in. |
| Trailing truck, journals | 8 in. by 14 in. |

*Boiler*

| | |
|---|---|
| Style | Extended wagon top |
| Working pressure | 200 lb. per sq. in. |
| Outside diameter of first ring | 80 in. |
| Firebox, length and width | 114 in. by 84¼ in. |
| Firebox plates, thickness | Sides, back and crown, ⅜ in.; tube, ½ in. |
| Firebox, water space | Front and sides, 5 in.; back, 4½ in. |
| Tubes, number and outside diameter | 244—2¼ in. |
| Flues, number and outside diameter | 40—5½ in. |
| Tubes and flues, length | 21 ft. |
| Heating surface, tubes and flues | 4,211 sq. ft. |
| Heating surface, firebox | 232 sq. ft. |
| Heating surface, total | 4,443 sq. ft. |
| Superheater heating surface | 980 sq. ft. |
| Equivalent heating surface* | 5,913 sq. ft. |
| Grate area | 66.7 sq. ft. |

*Tender*

| | |
|---|---|
| Journals, diameter and length | 5½ in. by 10 in. |
| Water capacity | 10,000 gal. |
| Oil capacity | 3,300 gal. |

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

## CHARACTERISTICS OF PLATE SPRINGS*

**BY GEORGE S. CHILES**

Part I (*Concluded*).

The test curve of a double elliptic tender truck spring which had been exposed to the weather on the storehouse platform for some time is shown in Fig. 7, the ordinates in this instance showing the distance between the bands instead of deflection. While this spring has only five plates in each section, the friction reaches a maximum value of 6,000 lb. This brings out clearly the large influence which friction may have upon the action of springs, especially those on which rust has accumulated.

Test curves of a locomotive driving spring are reproduced in Fig. 8. Curve *A* was taken just after the spring had been removed from the engine and curve *B* after it had been reset, retempered and the plates painted with oil and graphite before assembling. The decrease in friction resulting from the reworking of the springs and the introduction of a lubricant between the plates is very pronounced. The deflection for a load of 26,000 lb. has been increased from 1.35 in. to 2.1 in. A slight irregularity is apparent in the upper portion of the release load curve before the spring was reset. This is of quite frequent occurrence and is considered of little consequence so far as it affects the general law of the performance of springs. The curves obtained from this spring are very similar to a number of others obtained under similar conditions from springs differing considerably in design, flexibility and friction, and may be considered as fairly representative of the effect of service on the action of locomotive driving springs. They show that the prevailing opinion that springs become more flexible after a period of service is not well founded.

This conclusion is also borne out by experience with passenger car bolster springs. One of two springs removed from a dining car which had been shopped on account of hard riding is shown in Fig. 9. As near as could be ascertained these springs had been in continuous service for four years and one month, during which time the car had traveled a distance of 380,119 miles. The car was equipped with wooden trucks, which were scrapped.

*Part I commenced on page 161 of the April, 1915, number.

The condition of the old springs, however, seemed to warrant replacing them in the new trucks without resetting. In accordance with the usual practice at the shop in question several men, 16 in this instance, got upon the platform and jumped the car up and down to insure that the springs were working properly. Under this treatment the bolster springs showed no movement whatever, although the equalizer coil springs gave considerable movement. The springs were therefore removed from service and photographed. The reason for their stiffness is apparent from Fig. 9, which shows the extent to which rust had collected between the plates.

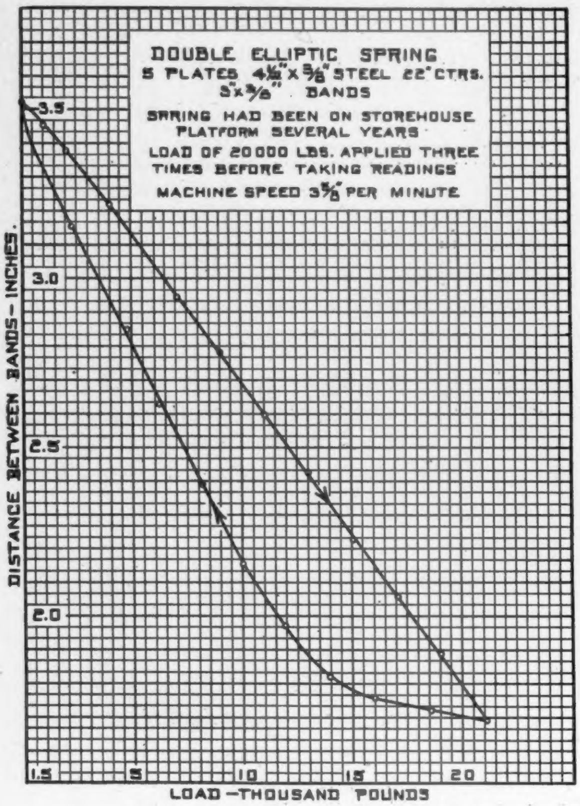



Fig. 7

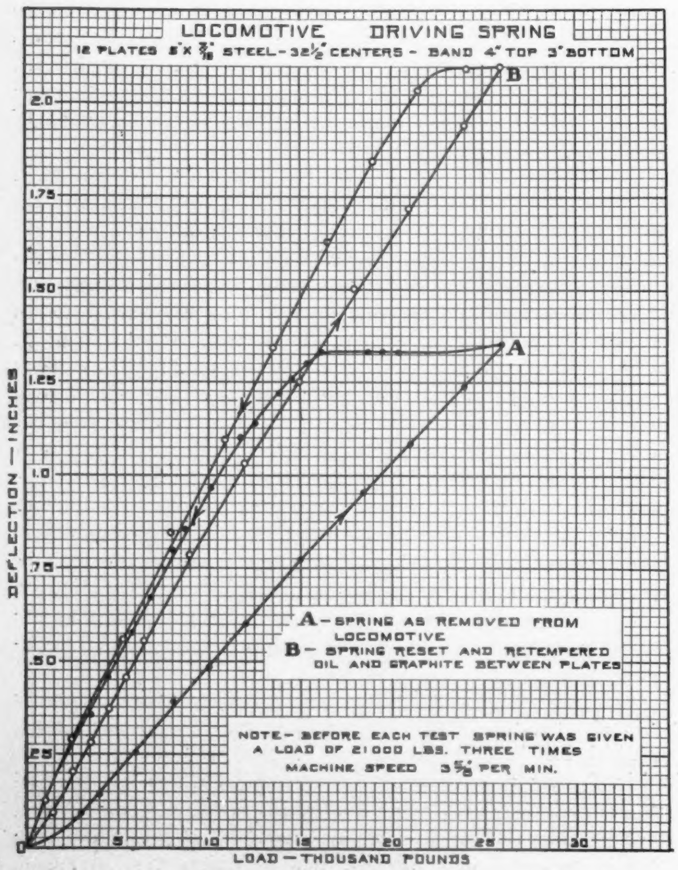



Fig. 8

### SERVICE HEIGHT OF SPRINGS

Attention has been called to the greater uniformity of release load curves as compared with application load curves. In order to determine which curve is nearer the actual height of springs in service, a coach was selected at random; the load on the four springs accurately determined by weighing the coach and deducting the weights unsupported by the springs, and the height of each spring calipered. The springs were then removed and tested, the lower part of the curves being reproduced in Fig. 10.

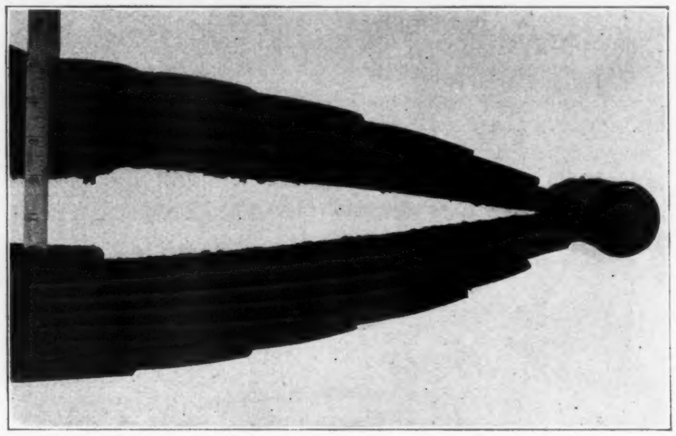
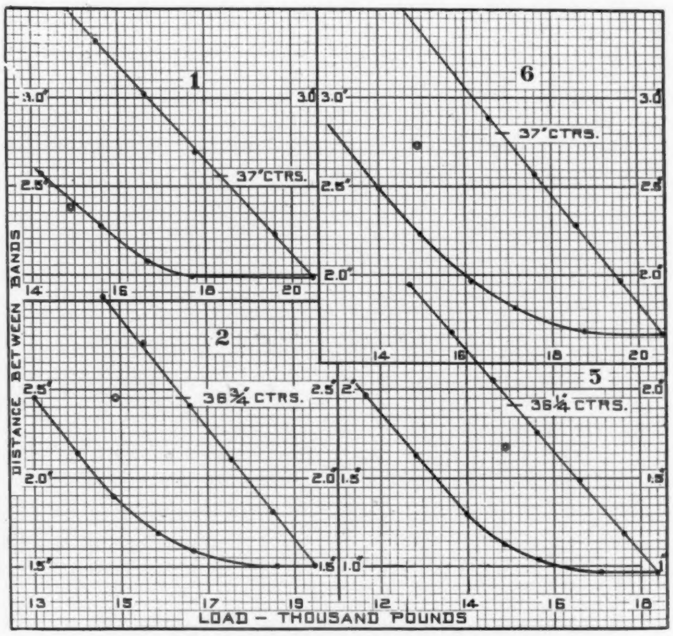


Fig. 9




DOUBLE ELLIPTIC BOLSTER SPRINGS
8 PLATES 4¼" x ⅜" STEEL - BANDS 3½" x ⅜"
OIL AND GRAPHITE BETWEEN PLATES WHEN SPRINGS WERE BUILT
TESTS MADE AFTER SPRINGS HAD BEEN IN SERVICE FIVE MONTHS UNDER PASSENGER EQUIPT. CAR
⊚ DENOTES DISTANCE BETWEEN BANDS
AVERAGE WEIGHT CARRIED BY EACH SPRING 14875 LBS.

Fig. 10

The heights of the springs as calipered under the car are shown by the double circles, which are plotted for loads of 14,875 lb., the average load for the four springs. For curve 1 this point falls practically on the release load line. For curves 2, 5 and 6

the points fall between the two lines; the first two mentioned being slightly nearer the applied load line, while the latter is nearer the release load line. In a similar test on springs from a cafe car, the calipered loaded heights of the springs removed from the range side of the kitchen end of the car are on the release load line, while those for the springs from the passageway side of the same end of the car practically coincide with the applied load curve. That is, the springs from the range side ride lower than those from the other side, which fact may explain why car foremen often make it a practice to place heavier springs, or springs of greater height, under the range side of the kitchen end of a car. This had evidently been done, for these springs were similar in all other respects except that those under the range side had seven plates, while the others had six plates. In case a car is heavier in one corner, it would perhaps be advisable to provide for it in the design of the springs, otherwise they may ride low and possibly take a permanent set.

These curves seem to indicate that the working height of a spring under a static load falls about midway between the ap-

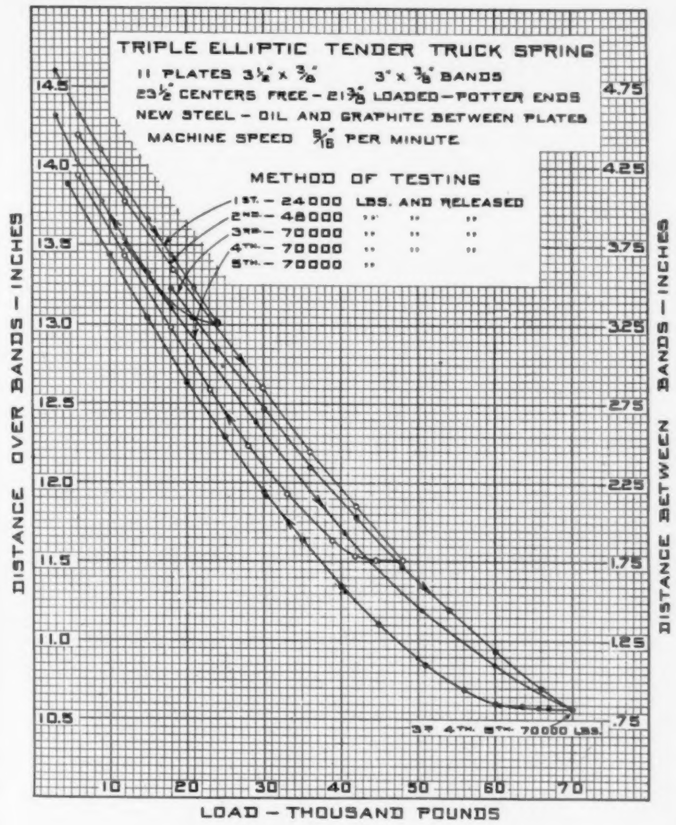



Fig. 11

plied and release load lines, favoring slightly the release load. Attention is called to the fact that the height of the springs was measured when the car was at rest. Doubtless when the car is in motion, the springs do not have the opportunity to adjust themselves that they do during the gradual retardation before the car stops, in which case the average running height probably approaches nearer to the release load curve. While the data relative to the service height of locomotive driving, trailing and tender truck springs is not complete, personal observation would seem to warrant the conclusion that these springs generally ride closer to the release load curve.

### PERMANENT SET

Early in the article the fact was brought out that the free height of a spring is often reduced by the applicaton and removal of the initial load. Assuming that the readings are free from error and neglecting the time effect, this reduction, often referred to as the initial set, may be due to either one or both of two causes. The first is the internal friction existing between the plates. This results partly from the imperfect fitting or camber of the plates, and is sometimes brought about by the use of plates of different thickness in the same spring. In the course of carefully conducted experiments, it has frequently come under the observation of the writer that a spring, constructed in such a manner that only slight initial stresses are set up in the individual plates when the band is applied, will not exhibit as marked a difference as an improperly constructed spring. Frequently, the spring can be made to return to its original free height by jarring it or allowing it to stand undisturbed for some time. Secondly, this reduction in free height may be caused by one or more of the plates of the spring taking a permanent set. This condition is shown in the curves of Fig. 11, in which a triple elliptic spring was loaded to 24,000 lb., without previously having been limbered up. After the removal of this load, a second load of 48,000 lb. was applied, the heights for the various loads being measured. Upon the removal of this load, three successive loads of 70,000 lb. each were applied and removed. The applied load curves are approximately parallel, but at some distance from each other, this distance being quite appreciable for the 70,000 lb. load. These curves would seem to indicate that a slight permanent set resulted from the application of the second load, although it is possible that the spring had not yet become thoroughly limbered up. The same is true for the third load. As the applied load curves for the fourth and fifth loads coincide, but are somewhat lower than the applied load curve for the third load, with the exception of the final or 70,000 lb. point, it would seem that having taken a permanent set for the first load of 70,000 lb., the set was not appreciably increased when this load was repeated in the fourth and fifth tests.

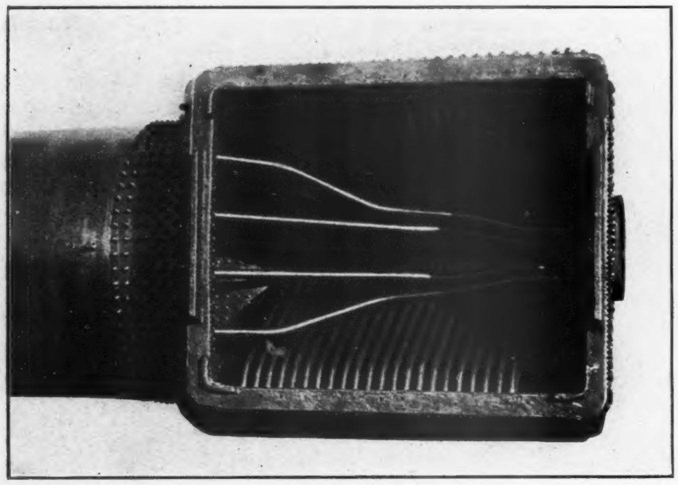
As in the case of any material which develops defects under test, it is customary to reject springs that take any permanent set at a specified test load. Generally speaking, the method of procedure in testing springs is more or less a matter of personal opinion, and it is questionable whether in all cases permanent set is detected. One method of testing which is quite generally followed in railroad shops consists in first giving the spring a load varying from 125 per cent to 150 per cent of the static load. This preliminary load is applied from one to three times, three applications being ordinarily specified, the free height of the spring being recorded upon its final removal. The loaded height, which is then obtained will vary according to the manner in which the spring is loaded. In some instances the static load is specified while other specifications require that an overload be applied and then released to the static load. Inasmuch as these two readings will be found to vary considerably some specifications call for the average of the two readings as the height of the spring under the load. Finally, after this load has been removed, the free height of the spring is measured and compared with the free height after the removal of the preliminary load to determine if the spring has taken any permanent set. Now had the spring referred to in Fig. 11 been tested according to either of these methods, it seems fair to assume that the permanent set would have taken place under the first application of the overload rather than under its repeated application or the application of the lighter static load. Had the spring been first loaded to 70,000 lb., an overload of approximately 150 per cent, it is plain that it would have taken a permanent set under the first application, and since no additional permanent set took place when this load was twice repeated, it seems certain that it would not have done so under its fourth application, or a subsequent application of the lighter static load of 48,000 lb. If this is true then this method of testing springs for permanent set is not trustworthy and the unreliability of a reapplication of the final load as a check is apparent.

The following method of testing for permanent set is suggested. Knowing the static load for which the spring is designed and having determined upon an overload, of say, 50 per cent of this static load, first, subject the spring to a load of 75

per cent of this overload, or in other words to a load equal to 112½ per cent of the static load. Having subjected the spring to this load from three to five times the free height should be recorded, after which the 150 per cent overload should be applied. This should then be removed and the free height ascertained and compared with the free height previously noted. Any variations between these readings would indicate that permanent set has taken place. In case a retest is necessary, the previous maximum load should be increased for each test by an additional load of say 10 per cent, or an amount sufficient to make evident any permanent set which has taken place. For laboratory tests, more accurate results could no doubt be obtained by taking the height of the spring after the load had been reduced to 40 per cent of the static load or less. In other words, light release load readings should be taken instead of the heights at no load, since the free height readings on the same spring quite often vary due to the manner in which the load is removed. Release load readings are quite often difficult to secure in an ordinary shop test, and this method is therefore not universally practicable.

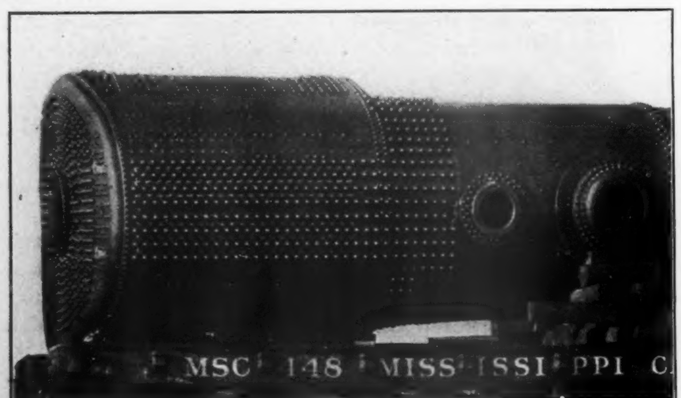
## WATER TUBE FIREBOX ON THE LACKAWANNA

In December last the Delaware, Lackawanna & Western received from the Lima Locomotive Corporation a Pacific type locomotive equipped with a special type of firebox, patented by S. S. Riegel, mechanical engineer of the Lackawanna.

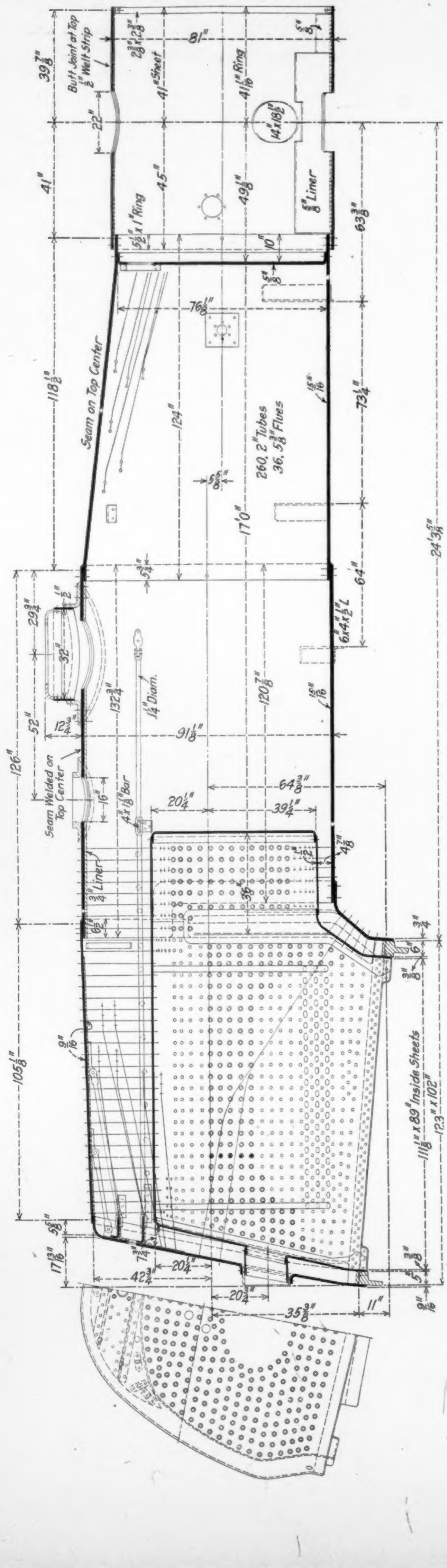


**Interior of the Firebox, Showing the Water Tubes and Arch Tubes**

Reference to the drawings will show the construction in detail. As will be seen there are two nests of water tubes with 66 2½ in. outside diameter tubes in each. The cross section of the fire-

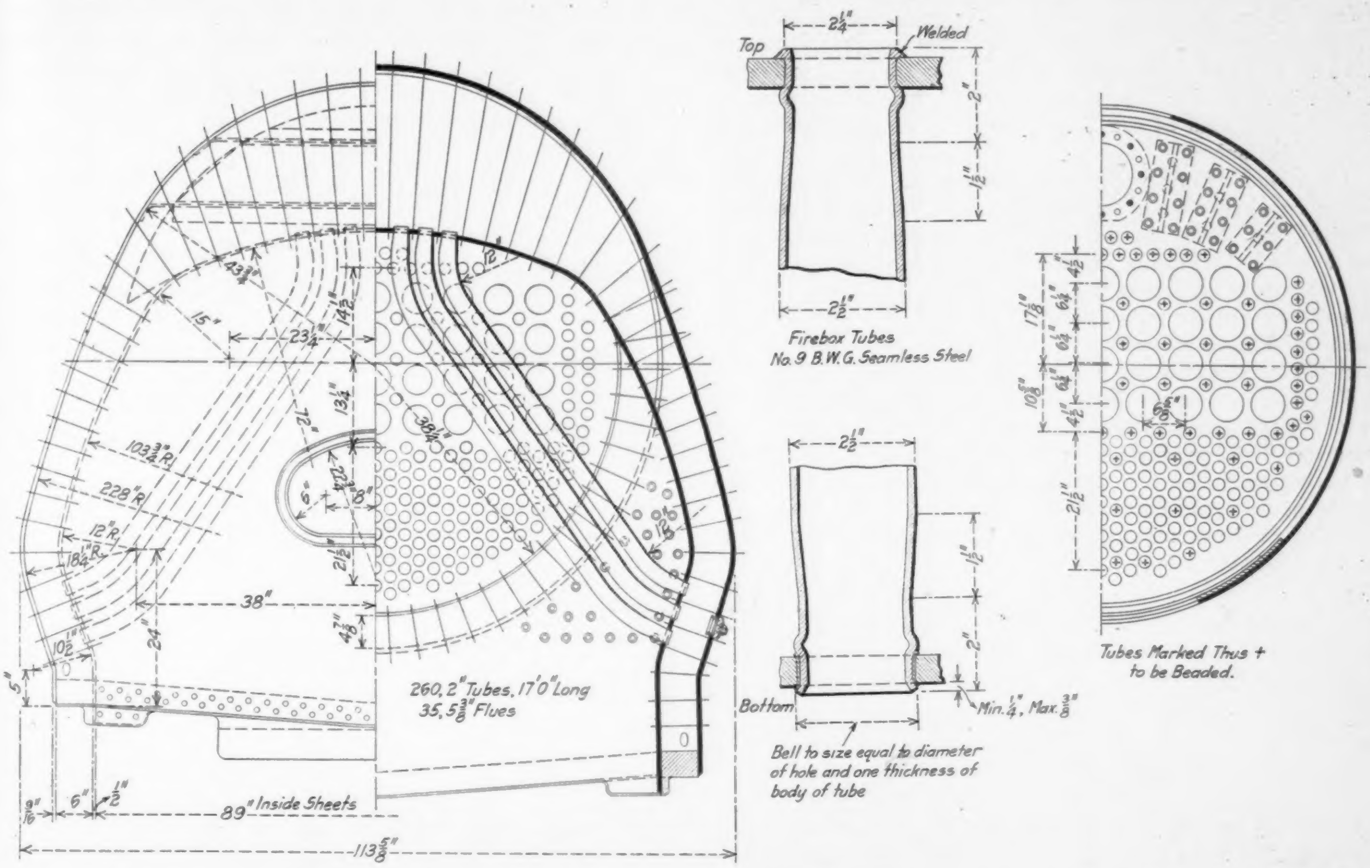


**Top of the Firebox, Showing Roof Sheet Plugs Opposite the Upper Ends of the Water Tubes**



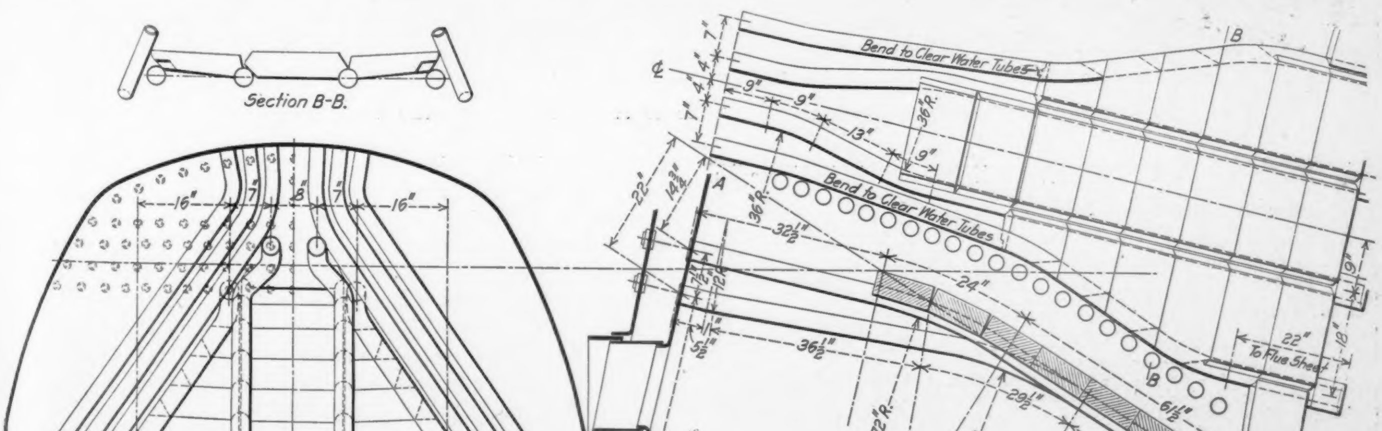
**Boiler with Water Tube Firebox Used on a Lackawanna Pacific Type Locomotive**

box shows the shape to which the side sheet is bent in order to permit a satisfactory connection between it and the lower ends of these water tubes, the bottom row of which is about 15 in. above the mud ring at the front end. The tubes are spaced at 4 in. centers and swing upward across the firebox space to the crown sheet, in which the ends are inserted. Plugs for cleaning purposes are placed opposite the ends of the tubes in the outer shell sheets, both top and bottom. The method of securing a tight joint in the two sheets is shown in the drawing of the boiler cross sections, but in this instance the water tubes are not welded in as shown on the drawing. Instead they are prossered, belled and beaded and set without ferrules in the top sheet, while the bottom ends are set with a ferrule, prossered, expanded and belled. These tubes are made of seamless soft steel, tested to 2,000 lb. per sq. in. hydraulic pressure before application.




**Cross Section Showing the Arrangement of the Tubes in the Firebox; in this Engine the Tubes Are Not Welded as Indicated**

The water tubes give a heating surface of 471 sq. ft., the total



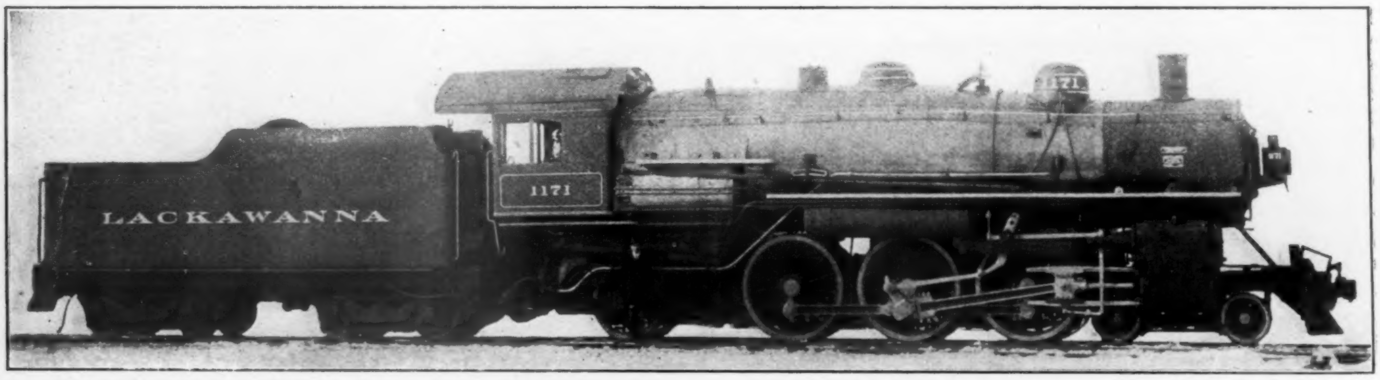

**Brick Arch Arrangement Used in the Water Tube Firebox**

heating surface of the boiler being 494 sq. ft. greater than that of other locomotives of the same class. The total heating surface for the engine with the experimental boiler is 3,960 sq. ft., while that of the sister locomotives is 3,466 sq. ft.; this does not include the superheater surface of 740 sq. ft. In the experimental engine the heating surface of the firebox and combustion chamber is 288 sq. ft., while that of the other engines of the same class is 267 sq. ft.; the tube heating surface for the experimental engine is 3,177 sq. ft., the same as that of the sister engines. A special application of the Security brick arch was made to the water tube firebox.

The object of the water tube construction was to obtain an improved circulation by providing definite cycles of circulation through these tubes in the zones of greatest heat intensity as well as to locate the heating surfaces to greatest advantage. While the locomotive has not so far been in service long enough to permit of any definite results being obtained, the performance has been so satisfactory with both bituminous and anthracite coal that the Lackawanna has ordered another engine fitted with this boiler, for use exclusively in fast passenger service. Considerable valuable information has been obtained showing its performance in comparison with the sister engines; further tests are being conducted, and it is expected at a later date that interesting performance data will be available.

A few of the principal dimensions of the locomotive are given in the following table:

| | |
|---|---|
| Class | 4-6-2 |
| Gage | 4 ft. 8½ in. |
| Diameter of driving wheels | 69 in. |
| Tractive effort | 43,200 lb. |
| Cylinders | 25 in. by 28 in. |
| Weight on leading truck | 50,000 lb. |
| Weight on drivers | 189,600 lb. |
| Weight on trailing truck | 58,000 lb. |
| Total weight of engine in working order | 297,600 lb. |




Lackawanna Pacific Type Locomotive, the Boiler of Which Has a Water Tube Firebox

| | |
|---|---|
| Coal capacity of tender | 10 tons |
| Water capacity of tender | 9,000 gal. |
| Total weight of tender loaded | 165,500 lb. |
| Total weight of engine and tender | 463,000 lb. |
| Rigid wheel base | 13 ft. |
| Wheel base of engine | 33 ft. 10 in. |
| Wheel base, engine and tender | 66 ft. 4 in. |
| Boiler pressure | 200 lb. |
| Grate area | 69 sq. ft. |
| Diameter of boiler | 78 in. |
| Firebox | 89 in. by 111 in. |
| Factor of adhesion | 4.39 |
| Water tubes, diam., gage and length, | 2½ in., O. D.; seamless steel, No. 9; 6 ft. average |
| Heating surface, firebox and combustion chamber | 288 sq. ft. |
| Heating surface, water tubes | 471 sq. ft. |
| Heating surface, fire tubes | 3,177 sq. ft. |
| Heating surface, arch tubes | 24 sq. ft. |
| Total heating surface of firebox | 783 sq. ft. |
| Total heating surface | 3,960 sq. ft. |
| Superheater heating surface | 740 sq. ft. |

PANAMA CANAL TRAFFIC.—During the first six months of its operation, 496 vessels were handled through the Panama Canal. These vessels carried a total cargo tonnage of 2,367,244, on which the tolls amounted to $2,126,832. A press despatch from Panama says that up to April 1, the tolls have amounted to $2,894,300, and that the total cost of operation and maintenance during the same period was $3,020,000, leaving a deficit of $125,700.

# GOOD FEATURES OF TENDER TANK DESIGN

BY WALTER R. HEDEMAN

Much attention is being given to the effect of locomotive detail design, both upon the cost of maintenance and the convenience of operation. The opportunities for improvement are not confined to the locomotive itself; tender tanks are a source of considerable trouble in the shop and on the road, which, partially at least, may be eliminated. It is the purpose of this article to describe a number of features of design which have proved valuable in reducing tank troubles and facilitating the making of proper inspections and repairs.

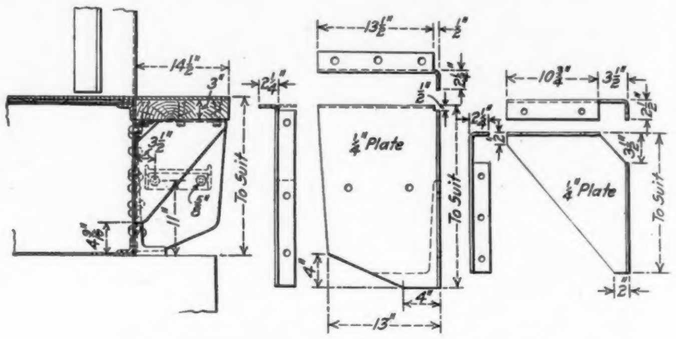



Fig. 1—Pressed Steel Tank Deck Supports

Where the tank and tender frames are of separate construction it is generally the practice to support the tank upon a wooden floor. If the floor is laid solid it is necessary to lift the tank from the underframe in order to locate and repair leaks which develop in the bottom sheet. It will be found of great assistance in making repairs between general shoppings of the engine to have the boards spaced from 6 in. to 9 in. apart, the rivets in the cross seams being located above the spaces, where they are readily accessible for calking. The length of the boards should be considerably shorter than the tank in order that access may be had to the rivets and seams along the side of the tank. Both the amount of tank leakage and cost of maintenance have been reduced since this practice was adopted.

Fig. 1 shows a type of tank deck support which is durable and simple in construction. These supports leave the front of the tank open for inspection below the deck and prevent the accumulation of fine coal against the tank sheets, which causes corrosion and wasting of the sheets.

Another means by which the cost of tank repairs may be reduced is shown in Fig. 2. In water bottom tanks the bottom of the coal pit is covered with a ¼-in. plate, resting on ⅜ in. by 1½ in. spacing strips. It extends forward from the slope sheet seam to the front of the tank deck, to which it is secured by lag screws. It protects the water-bottom roof sheet from wear,

and when worn out its renewal is an easy matter compared to the laborious operation of renewing or patching the tank sheet.

With the usual form of tank manhole, it is a difficult matter in making water stops to accurately spot a locomotive hauling

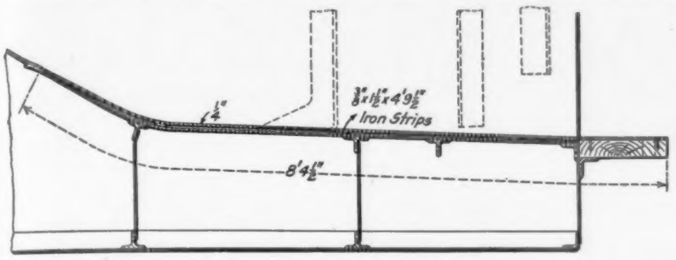



**Fig. 2—False Shovel Sheet**

a heavy passenger train. It is frequently necessary to stop with a suddenness that is very disagreeable to the passengers. Fig. 3 shows a manhole designed to increase the range within which

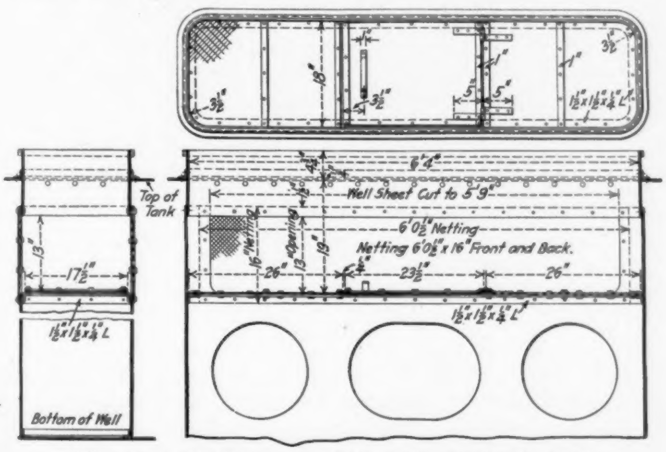



**Fig. 3—Long Tank Manhole with Enclosed Well**

service from the water crane may be secured. It is 18 in. wide by 6 ft. 4 in. long and permits the engine crew to reach the water crane anywhere within a distance of about 10 ft. The large

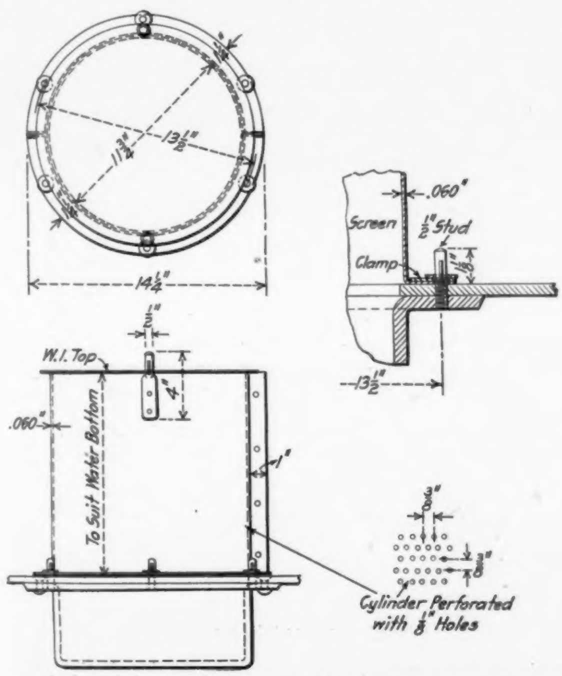



**Fig. 4—Tank Strainer Used with Outside Tank Valve**

tanks of modern passenger locomotives extend back of the coal space for a sufficient distance to permit the use of this construction. The manhole sheets extend from the top to the bottom of the tank, the sides being cut away for a depth of 13 in. from a point about 6 in. below the top. The openings thus formed are covered with 2½ in. by 2½ in. wire mesh, a screen of the same mesh being placed across the well below the openings. The large holes shown in the walls below the screen are located about midway between the top and bottom of the tank. The bottom of the well forms a trap for sediment which passes through the screen; it has been found that considerable hard matter accumulates at this point. The horizontal screen is made in three sections, which are readily removable for cleaning out the bottom of the well. The cover of the manhole is also made in three sections in order that each part may be easily handled.

While the well below the manhole accumulates a large amount of fine material which would otherwise enter the tank, it has

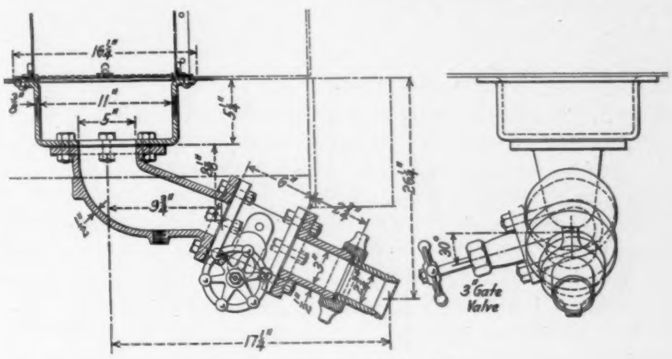



**Fig. 5—Outside Tank Valve**

been found desirable to cover the tank well with the strainer shown in Fig. 4, as an additional protection to the injector from small particles of coal which may be carried through to the tank. With an outside tank valve this strainer can be made exceptionally tight. No provision is required through the top for the passage of the tank valve rod; the only openings are the ⅛-in. perforations through the cylinders.

Tank valves operated from the deck by means of a rod extending up through the tank, have been a source of much trouble on water-bottom tanks. Unless the tank is built with a well surrounding the rod, a packing gland is required where the rod passes through the water-bottom roof sheet, and considerable trouble is experienced in keeping this tight. The valve is inaccessible and can be given very little attention. With a gate valve applied outside of the tank, as shown in Fig. 5, very good results have been obtained. The valve is accessible and can be readily packed; when open it offers an unobstructed passage.

## TESTS OF LUBRICANTS

BY H. M. BAXTER

In large plants, where a chemist is constantly employed, the testing of lubricants, together with all other materials, is common practice. For smaller shops, where constant testing is rendered impracticable owing to the expense and time involved, it is necessary to purchase ready-to-use lubricants, or, where economy is required, the pure natural products. The latter course, while more economical and far superior to using the cheaper prepared products, is one that requires some knowledge of the qualities required in the lubricant to best meet the conditions of various classes of service. In judging the purity and usefulness of oil, the practical analyst usually makes eight different tests. While no attempt is made to give in detail the methods of conducting these tests, the writer believes that the following general outline of the points to be investigated may be of help to those who are interested in lubrication.

The first test is for specific gravity, which may not necessarily be of paramount importance in itself, but is invaluable as an eliminating test. For instance, pure sperm oil has a specific gravity of 0.883, and while the specific gravity of some other oils or mixtures may possibly be the same, any other degree

instantly stamps the same as impure and the test need be carried no farther. The second test is made with the aid of alkalies, which clearly show whether the sample is pure, fatty (of either vegetable or mineral origin), hydrocarbon (mineral), or a mixture of both. This information is of great value owing to the varying degrees of spontaneous combustion possessed by the several grades of oil, which property should be carefully considered. The third is the sulphuric acid test giving the true color value in determining the source of fatty oils.

The free acid test is fourth and is one of the most important, as a very small proportion of free acid will attack the bearing metal, this action being especially severe on copper or brass. An oil containing a fraction of 1 per cent of free acid will dissolve sufficient brass within a few hours to take on a decidedly greenish tint. The fatty vegetable oils usually possess free acid, ranging from a fraction of 1 per cent to a considerable proportion of their bulk, and as they become rancid the free acid increases. Properly refined mineral oils do not carry any free acids, nor do they develop any with age or exposure.

The fifth test is for viscosity, or body. The old fashioned axle grease, thick as cold butter, was extremely high in viscosity, while the many modern trade-marked oils, which are invariably light mineral oils, recommended for general use on sewing machines, oil-stones, etc., are almost as thin as water with a correspondingly low viscosity. The correct degree of viscosity depends upon the use for which the oil is intended. Heavy or fast running machinery requires a heavy, thick oil, whereas a delicate mechanism requires a thin, light oil. The sixth is the flash point test, which determines the effect of heat upon the oil. This includes the determination of the dangerous spontaneous combustion, or flash point as well as the unpleasant vaporizing, or smoking point. The temperature at which an oil will flash is often used as an indication of its viscosity or body, it being much easier to make the flash test than to directly determine the viscosity. This is based upon the assumption that the more body an oil possesses, the higher the temperature required to give off inflammable gases. This test also has a direct bearing on the tendency of the oil to gum, as it is the oxidization of the oil which causes it to assume a gum-like consistency. Seventh is the evaporation test. No good lubricating oil should lose more than one-quarter or one-half of 1 per cent of its weight when subjected for several hours to a temperature of approximately 212 deg. Fahrenheit. A good cylinder oil subjected for several days to a constant temperature of 350 deg. Fahrenheit, should not lose over 5 per cent in weight.

An eighth test is sometimes made with acetic acid to ascertain the temperature at which an oil will lose its clearness and become muddy or turbid. While this is not of vital importance it is of interest when choosing the better of two nearly equal oils, as a clear oil is more desirable than a muddy one. The essential requirements of a successful lubricant will be determined by the first seven tests.

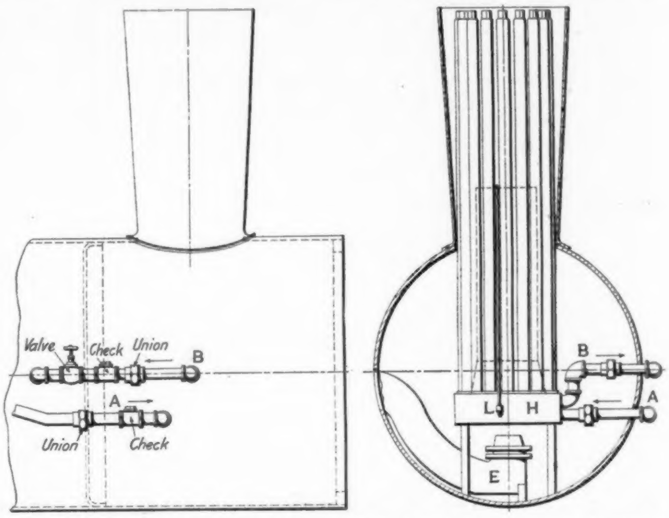
# FEED WATER HEATER USED ON GEARED LOCOMOTIVES

BY HAROLD S. JOHNSON

The accompanying engravings show a type of front end feedwater heater used on the Shay geared locomotives of the Tamalpais and Muir Woods Railway in California. There are five locomotives fitted with this type of heater and it has been in use on this road for over ten years, with satisfactory results.

The heater consists of a cast iron header *H* which rests on legs directly over the exhaust nozzle *E*. The header is divided into two compartments; the lower compartment is tapped to accommodate 16—¾ in. tubes and the upper compartment is tapped to accommodate 16—1½ in. tubes. The 1½ in. tubes have plugs welded in their upper ends, squared on top so that the tubes can be easily applied and removed by the aid of a socket wrench. The ends of the ¾ in. tubes are open and these tubes terminate several inches below the ends of the 1½ in. tubes.

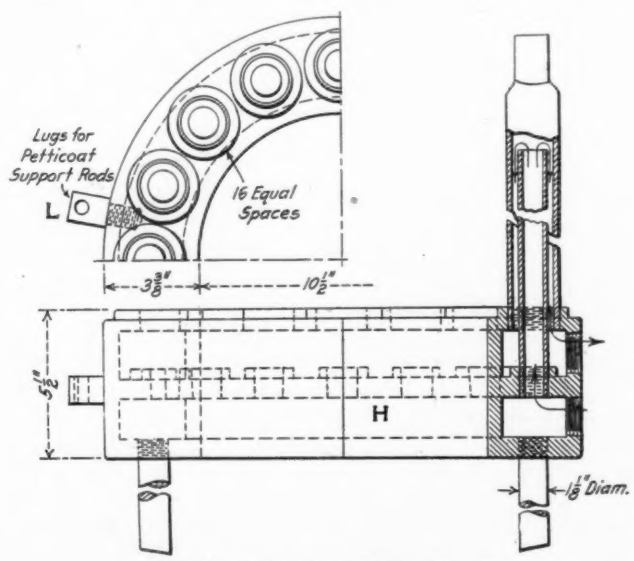
After leaving the injector the water passes through 1½ in. pipe *A* to the lower compartment of the header, thence up through the ¾ in. tubes and down through the 1½ in. tubes as indicated by the arrows, after which it passes out of the header and into the boiler through connection *B*. The hot gases passing up through the stack heat the water circulating through the heater. In a recent test on a locomotive pushing one light car




Arrangement of Feed Water Heater Used on a Shay Geared Locomotive

up a 7 per cent grade it was found that the average temperature of the feed water, after leaving the injector and before passing into the heater, was 184 deg. In circulating through the heater the temperature was maintained at 204 deg., making a rise in temperature of the feedwater of 20 deg. With a load consisting of three of the light cars in use on the Tamalpais road the feedwater temperature after leaving the heater was maintained at a temperature of 230 deg., making a rise in temperature of 46 deg.

The locomotives equipped with this heater use a good quality of water and no trouble is ever experienced with scale. The




Details of the Feed Water Heater

only trouble ever caused by these heaters is the tendency of the water to eat away the bottoms of the tubes, but this can largely be done away with by the use of a better quality of tube. Common black pipe is used in the heaters at present. The life of a set of tubes is from four to five years, with one or two rethreadings of the ends on account of the action of the water.

# CAR DEPARTMENT

## CONSIDERATIONS AFFECTING THE TYPE OF CENTER SILLS IN STEEL PASSENGER EQUIPMENT

BY L. K. SILLCOX
Assistant Mechanical Engineer, Canadian Northern, Toronto, Ont.

The writer recently had occasion to discuss the question as to whether built-up fishbelly or rolled steel center sills are preferable for use in conjunction with a steel side construction. Apart from any personal opinion, it is believed that consideration should first be given to the matter of weight per lineal foot of car body, assuming, of course, an ample factor of safety in the structure to meet operating conditions as encountered in general.

In determining on the design of a steel car, there should first of all be taken into account past practice in wooden car construction. The wooden car which is being discarded today is the result of many years' refinement in design and possesses many requirements which it would be advisable, if possible, to duplicate in steel construction. One of the reasons for the remarkable performance of the wooden car in resisting all but destructive impact forces, is its flexibility. No metal underframe of any type can ever give satisfaction unless there is a proper regard for flexibility in the design; if this is not present there is nothing that will absorb impact shocks and disseminate buffing strains. It is also unreasonable to expect to obtain a maximum factor of safety in the car itself or even obtain a reasonable service from couplers and draft attachments, unless a high capacity draft gear is provided. It is required in the designing of postal cars that 400,000 lb. be assumed as the shock necessary to be absorbed. The United States Railway Mail Service department acted conservatively in deciding upon this figure, since it has been found in several tests that shocks may be as high as 600,000 lb. or more.

The center sills in a car are in compression when performing their most difficult function. The strength of any construction in compression depends on the uniformity of the material, the arrangement of the section, the unit cross sectional area, and the length between supports. The center sills form a beam supported at two points, and having overhanging ends and have to be arranged to resist buckling or crushing due to the load of 400,000 lb. already mentioned. In a steel beam or column designed to absorb this impact force, considering 28,000 lb. per sq. in. to be the elastic limit of the steel, the minimum area required would be $400{,}000 \div 28{,}000 = 14.28$ sq. in.

The height from the track to the center of the coupler is determined by law and the customary height of the floor above the coupler is regulated by the required height of platform buffers. In general, this is 16 in. above the center of the coupler. In wooden car construction the center sills are shallow and the coupler is supported below them. Loads upon the underframe brought about by buffing tend to bend down the ends of the car, due to the fact that it is impossible to provide camber at the center of steel center sills without allowing it to take a natural slope to the extreme end of the center sill structure; that is, practice has proved the impracticability of trying to mechanically secure the camber in the sills, so as to have the portion from the bolsters to the end of the car come parallel with the rail.

The ideal underframe should have all members join each other in the same plane, so as to prevent buckling due to eccentric loading; each member should also be designed to perform its individual functions, passing the stresses from one member to the other. The central portion of any underframe is exposed to receive initial impacts on account of the prevailing design of convex end, which is necessary in order that equipment may properly clear on curves when coupled in trains. This portion should therefore be made strong enough to take the greatest buffing shock assumed to be encountered in service. As has already been shown, the underframe receives the force of end collision as a column load on its longitudinal members, while the end frame receives it as a transverse load on its exposed members. Under these circumstances it is obviously impracticable to make the end frame equally strong with the underframe; furthermore, it is evident that provision ought to be made to protect the end frame from destructive forces. A strong side construction is admittedly a valuable asset in providing additional end frame protection. In designing an end frame it has been the writer's practice to assume it to be a beam supported at its upper and lower ends and loaded at a point 18 in. above the car floor line, as it is generally considered that in case of two cars tending to telescope the point of maximum shock is never above this point. Connections are provided between the end frame and the remainder of the car frame of sufficient value to develop the full transverse strength of the end frame; the vertical members of the latter are connected by horizontal members so that in case the end frame is loaded to destruction the connections are sufficient to separate all the longitudinal members of the car frame and when they yield all parts will be forced toward the center at the end of the car, thus affording a maximum of resistance to any telescoping action between adjoining cars in a train.

There are some rather important functions which the underframe is called upon to perform. Not only must it sustain the weight of the superstructure and load (this embodies only that portion from a point about 12 in. inside the bolster, to the end, for shallow sills), but it must withstand impact, oscillating and pulling strains without distortion. Were it not for these conditions the underframe might be considered as a steel span resting upon the center plates. The design must also be reasonable with respect to material forming the frame, without excess weight, in addition to being strong enough to resist compressive strains of large magnitude.

A careful analysis of the prevalent systems of passenger car underframe design will be found of material help in deciding the best construction for any given case. Generally speaking, there are four theories of design now in practice and in order to properly present the subject, there are shown five designs for cars actually in service covering these four classes, and one additional showing the present practice on the road with which the writer is connected. The four types of design are:

1. Underframe designed to carry the whole weight on the center sills only.
2. Underframe designed to carry the whole weight on the center sills with a sustaining side girder.
3. Underframe designed to carry the load equally distributed on side and center sills.
4. Underframe designed to carry pulling and buffing loads only.

The first type has reference to a construction where deep center sills are used in conjunction with a light side girder, as shown in Fig. 1. Most underframes of this type now in service are built with cast steel end portions which include in one casting the body bolster, platform, side and center

sills extending as far back as the bolster. This design of framing requires very deep sills, which represent additional weight over that necessary for any other type. Unquestionably the lightest car designed to uniform specifications as to strength would not be found among this first class. This additional weight does not mean an extraordinary increase, as from direct comparison it would appear not to exceed 4,000 lb. per car under usual circumstances, but on account

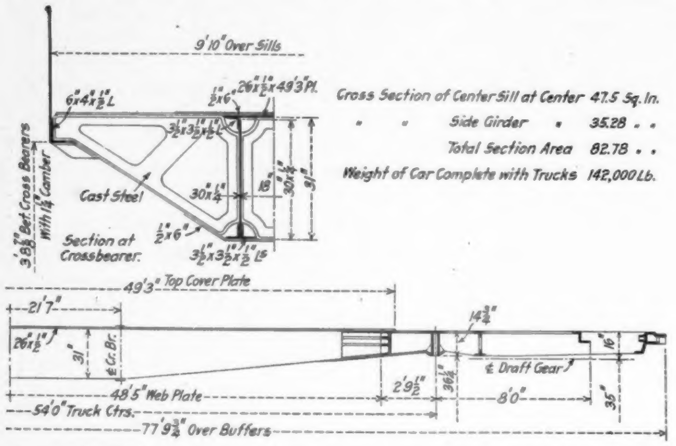



**Fig. 1—Underframe with Deep Center Sills and Light Side Girders**

of the necessity of the center framing having to sustain its own weight and that of the entire superstructure without deflection on a long span, it is necessary to use too much metal to be economical. With this style of framing, it is possible to secure a center line of draft coinciding with the neutral axis of the center sill at the center of the car. The stress per square inch on the center sills, due to any assumed maximum force of impact, would be equal to this force divided by the area of the section to be analyzed. Where such deep sills are used, it sometimes happens that the neutral

Cross Sectional Area at Center, Center Sill 42.61 Sq. In.
" " " " , Side Girder 28.36 " "
" " " " Total 70.97 " "
" " " Draft Gear 27.25 " "
Light Weight of Car with Trucks 139,000 Lb.

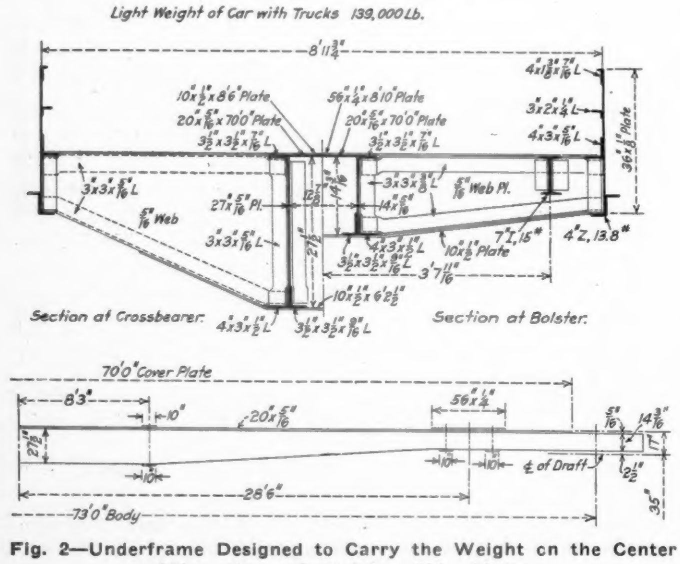



**Fig. 2—Underframe Designed to Carry the Weight on the Center Sills, with a Sustaining Side Girder**

axis of the section will come above the center line of the coupler, which adds to the total combined compression. This fact has helped to discourage the use of a framing like this.

In dealing with the second type, it can be stated that its greatest value appeared to be established during the period of the composite car; in fact, it is widely used at the present time for such construction. By referring to Fig. 2 it can be readily seen how the members naturally adapt themselves to the application of wooden side framing. Many of the features common to the wooden underframe are discernible. This style of framing is somewhat lighter than that just considered. It served its purpose fairly well and did not affect the old style wooden side framing to any great extent, except in the replacing of the usual diagonal bracing by side blocking with straight planking.

In considering the third class, where it is assumed that the side and center sills sustained an equal share of the total vertical loading due to weight of construction and equipment appliances, the construction shown in Fig. 3, which is employed by one of the large car builders, has been selected. As an elementary consideration, an evenly distributed load is assumed over the entire length of the sills, and in the calculations only that portion of the load which comes between the truck centers is considered. The effect of the overhang

Cross Section of Center Sill at Center 47.073 Sq. In.
" " " Side Girder " " 31.14 " "
" " at Center Total 78.213 " "
" " " Draft Gear 35.66 " "
Weight of Car Complete with Trucks 141,000 Lb.

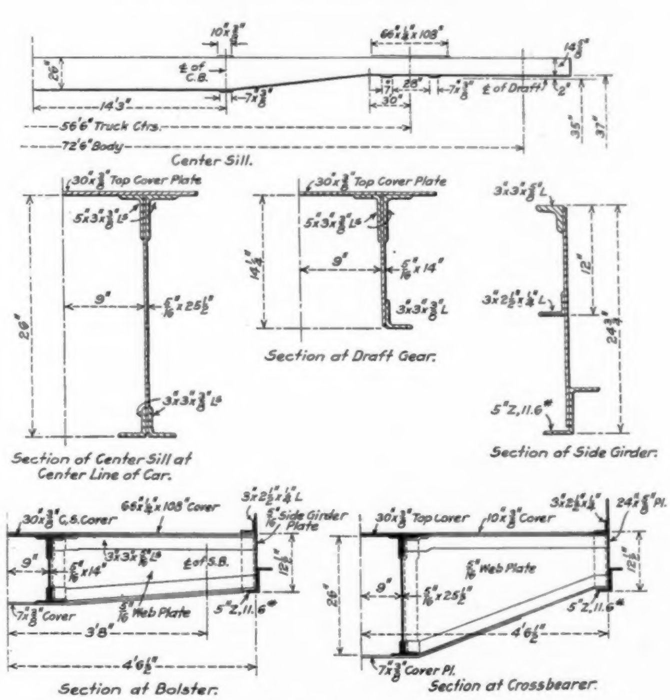



**Fig. 3—Underframe Designed to Carry the Load Equally Distributed on Side and Center Sills**

is neglected, which, if taken into account, would reduce somewhat the fiber stresses obtained at the center of the car. The section moduli of both side and center sills are generally combined to arrive at the maximum stresses produced by the loading. This is based on the assumption that there is no connection between the center sills and the side girder, but it would not seem unreasonable to assume that the crossties, bolsters and end sills tie these members together in such a way that we obtain far more strength from them together than we apparently obtain by adding the strength of the two members; that is, if we consider the steel in the side girder and center sills as one member and take the center of gravity of the entire structure, a much higher section modulus would be obtained than under the system named above, resulting in a considerably lower fiber stress. For a construction such as that under consideration, assuming truck centers 56 ft. 6 in. apart, it is reasonable to suppose that if the girder is designed to take care of the load for this distance, there ought to be no question of having a large margin of safety for any buffing stresses that might develop.

A rather large proportion of the all-steel cars built recently

are fitted with deep center sills. There is probably some good reason for this, but it is the writer's object to show some good reasons for the use of a shallow center sill. Undoubtedly, the point of chief interest centers around the question of weight. The writer has not been able to find a single case where any decrease in weight was obtained from a car having a steel side construction in conjunction with a fishbelly underframe, as compared with the same class of car with channel center sills. The following table is based on actual weights covering several styles of recent construction:

| Class of car | Design of underframe | Light weight of body, lb. | Light weight per lineal ft., lb. |
|---|---|---|---|
| Baggage.......... | Fishbelly | 76,160 | 1,268 |
| Baggage.......... | Fishbelly | 94,160 | 1,298 |
| Baggage and Postal | Fishbelly | 103,500 | 1,478 |
| Baggage.......... | Fishbelly | 90,580 | 1,298 |
| Baggage and Postal | Fishbelly | 79,800 | 1,330 |
| Baggage and Postal | Fishbelly | 82,640 | 1,377 |
| Baggage.......... | Fishbelly | 83,400 | 1,264 |
| Baggage.......... | Channel | 91,360 | 1,260 |

It is not to be denied that there are advantages to be derived from the use of fishbelly underframes, but for a car having steel side construction it is not believed by the writer

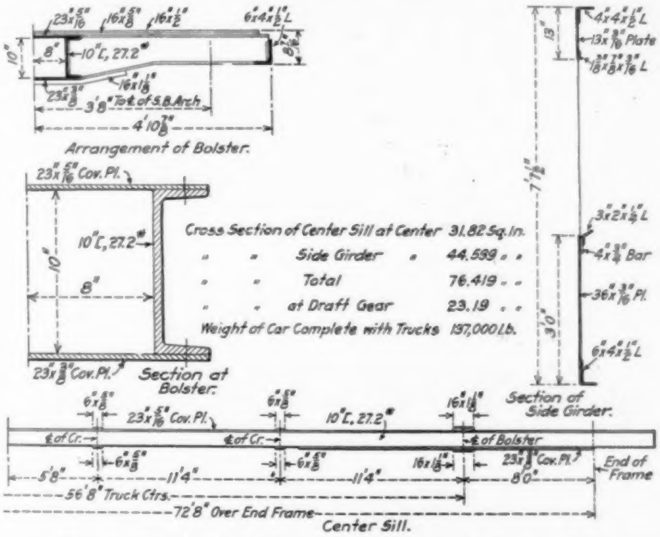



Fig. 4—Coach Underframe with Channel Center Sills

to be best. The foregoing table deals only with blind end equipment; Fig. 4, however, illustrates the present practice for coaches of one of the large roads and this car is also referred to in the last line of the following table:

| Class of car | Design of underframe | Light weight of body, lb. | Weight per lineal ft., lb. |
|---|---|---|---|
| Coach............ | Fishbelly | 103,040 | 1,467 |
| Coach............ | Fishbelly | 101,920 | 1,456 |
| Coach............ | Fishbelly | 97,000 | 1,338 |
| Coach............ | Fishbelly | 103,000 | 1,411 |
| Coach............ | Channel | 97,000 | 1,329 |

The cars referred to in this table are all in operation and an analysis of the sections considered shows that no matter what view the designer has taken of the subject, practically the same total number of square inches of material is provided in each case, with a slight showing in favor of the channel underframe type. We must, therefore, conclude that any advantage which one design is believed to have over another is the result of practical reasoning.

The operating man appreciates a construction where ease of inspection is possible, which certainly is not true of the fishbelly underframe; neither does this type lend itself easily to the application of electric lighting apparatus on account of the absence of sufficient clearance at the truck end sill. The structure is more or less weakened by having to be cut for the necessarily large number of pipes, conduits and levers unless additional metal is provided around the openings for reinforcement. It is very difficult to apply steam heat drips at the crossover and to apply rods and piping in the center of the car. The sills have to be spread at least 18 in. apart if top inside flange angles are used, to enable the structure to be riveted up, as the rivet bucker cannot be accommodated in less space than this.

Great care is necessary to secure the proper camber for fishbelly underframes. For instance, the design in Fig. 2 has the camber provided for differently from that in Fig. 3. In Fig. 2 there is ¾ in. camber in the top angle only of the center sill; the plate runs straight with the top and bottom edges parallel to the rail. The rivet gage in the top angle is 2¼ in. for the entire length, starting 2⅛ in. down on the web plate at each end and rising to 1⅜ in. at the center of the car. In Fig. 3 there is a ¾ in. camber in the top angle only; the plate runs straight with the top and bottom edges parallel to the rail. The rivet gage in the top angle is 2 in. for the entire length, starting 1⅞ in. down on the web plate at each end and rising to 1⅛ in. at the center of the car. In both cases, 1¼ in. camber is provided in the side girder.

To secure a permanent camber in cars having shallow center sills is simply a matter of providing good workmanship and having the rivet holes true to gage and the rivets well driven. This is one of the secrets of this type of frame where top and bottom cover plates are used and it accounts for fully half the deflection occurring when a car is in the course of construction. It is usual to provide about 1½ in. camber at the center of the side frame and center sills in this type of construction, which results in a minimum ¾ in. finish camber when the car is complete.

Again referring to the wooden car, the last design built for

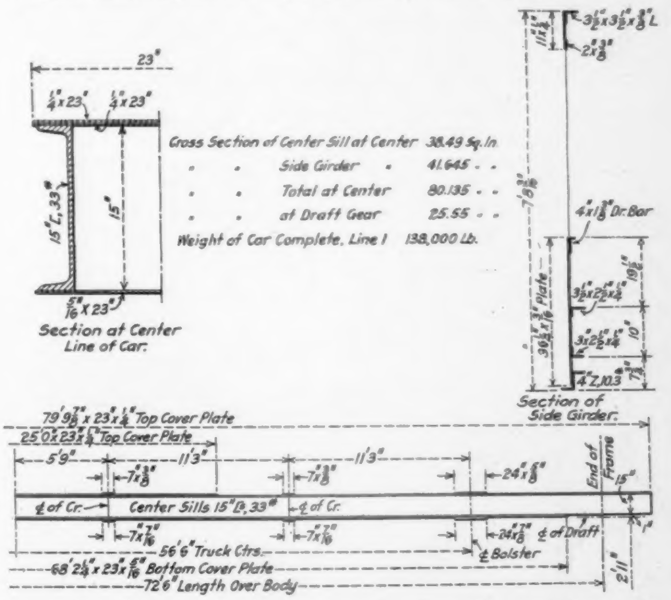



Fig. 5—Underframe Used on the Canadian Northern

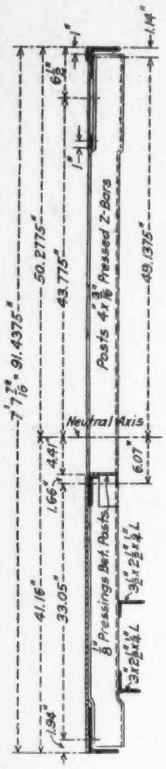
the company with which the writer is connected was fitted with four 5 in. by 9 in. wooden sills, so located as to be nearly uniformly affected by end strains. There was a total cross sectional area of 180 sq. in. in this section with a section modulus of 270, the center of the draft gear being 11.5 in. below the neutral axis of the section. Based on a 400,000 lb. buffing shock with 150,000 lb. absorbed in the draft gear we have

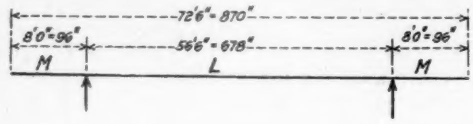
$$\frac{250{,}000 \times 11.5}{270} = \frac{2{,}875{,}000}{270} = 10{,}649; \quad \frac{250{,}000}{180} = 1388.$$

Adding, this gives 12,037 lb. per sq. in. fiber stress. Considering the design shown in Figs. 5 and 6, which is a steel construction having 38.49 sq. in. area with a section modulus of 103.13, there being a drop of 8.5 in. between the draft gear center line and the neutral axis, we have $\frac{2{,}125{,}000}{103.13} + \frac{250{,}000}{38.49}$ $= 27{,}300$ lb. fiber stress.

It is now the usual practice to use elastic limit as a basis

in comparing the relative value of steel and wood in car construction. The elastic limit of open hearth steel ranges close to 28,000 lb. and that of B. C. fir, such as is used for sills, averages 6,400 lb.; we then obtain a ratio of 28,000 ÷ 6,400 = 4.4. This is pointed out to sustain the contention that the stress shown for steel center sills is safe. The method of calculation does not take into account anything but absolutely maximum conditions. If the whole buffing shock were taken on the buffers we should have 400,000 ÷ 38.48 = 10,400 lb. per sq. in. at the center and 400,000 ÷ 25.55 = 15,700 lb. at the ends of the car, which gives a ratio of 15,700 ÷ 400,000 = 0.039.




| | |
|---|---|
| Side plate angle—4 in. by 4 in. by 3/8 in.; 1/2 in. rivets; 3 in. spacing. | Area = 2.86<br>I = 4.4<br>Arm = 49.1375 |
| Letterboard plate—13 in. by 3/16 in. | Area = 2.44<br>I = 34.33<br>Arm = 43.775 |
| Side plate angle bar—2 in. by 3/8 in.; 1/2 in. rivets; 3 in. spacing....... | Area = .75<br>I = .250<br>Arm = 49.2775 |
| Letterboard bottom bar—2 in. by 3/8 in.; 3/8 in. rivets; 3 in. spacing. | Area = .75<br>I = .250<br>Arm = 38.2775 |
| Belt rail angle—4 in. by 1 3/8 in. by 7/16 in.; 1/2 in. rivets; 3 in. spacing. (May be cut from 4 in. by 2 1/4 in. by 7/16 in. angle if Illinois Steel Co. S-5 dropper bar cannot be procured.) | Area = 2.21<br>I = 2.86<br>Arm = 6.07 |
| Girder plate—36 in. by 3/16 in..... | Area = 6.75<br>I = 730.94<br>Arm = 23.16 |
| Bottom angle—6 in. by 4 in. by 3/8 in.; 5/8 in. rivets; 3 in. to 3 1/2 in. spacing. | Area = 3.61<br>I = 13.47<br>Arm = 39.22 |

Neutral axis for compound section $= x = 41.16$ in. from bottom of side sill.

Moment of inertia (I) for compound section $= \Sigma I + Ah^2 = 23{,}732.425$

Bending moment at center of car, neglecting overhang which would reduce F. S. (Assume all load carried by side framing):

| | |
|---|---|
| Estimated light weight of car body 72 ft. 6 in. long....... | = 103,000 lb. |
| Estimated weight of passengers and equipment........... | = 9,000 lb. |
| Total weight ........................................ | = 112,000 lb. |
| Load per side ........................................ | = 56,000 lb. |
| Load per unit length — 56,000 lb. ÷ 870 in............. | = 64.36 lb. |

$$M = W\left(\frac{l^2}{8} - \frac{M^2}{2}\right) = 64.36\left(\frac{678^2}{8} - \frac{96^2}{2}\right) = 3{,}401{,}487.9$$

Maximum fiber stress:

$$S = \frac{M\,c}{I} = \frac{3{,}401{,}487.9 \times 50.2775}{23{,}732.425} = 7{,}590 \text{ lb. per sq. in. max. fiber stress in sides.}$$

Center sills:

| | |
|---|---|
| Area of two 15 in., 33 lb. channels..................... | = 19.8 sq. in. |
| Area of cover plates, two top, 23 in. by 1/4 in.; one bottom, 23 in. by 5/16 in.................................. | = 18.69 sq. in. |
| Total ........................................ | = 38.49 sq. in. |
| Assumed maximum buffing stress........................ | = 400,000 lb. |
| Unit buffing stress = 400,000 ÷ 38.49.......... | = 10,400 lb. per sq. in. |

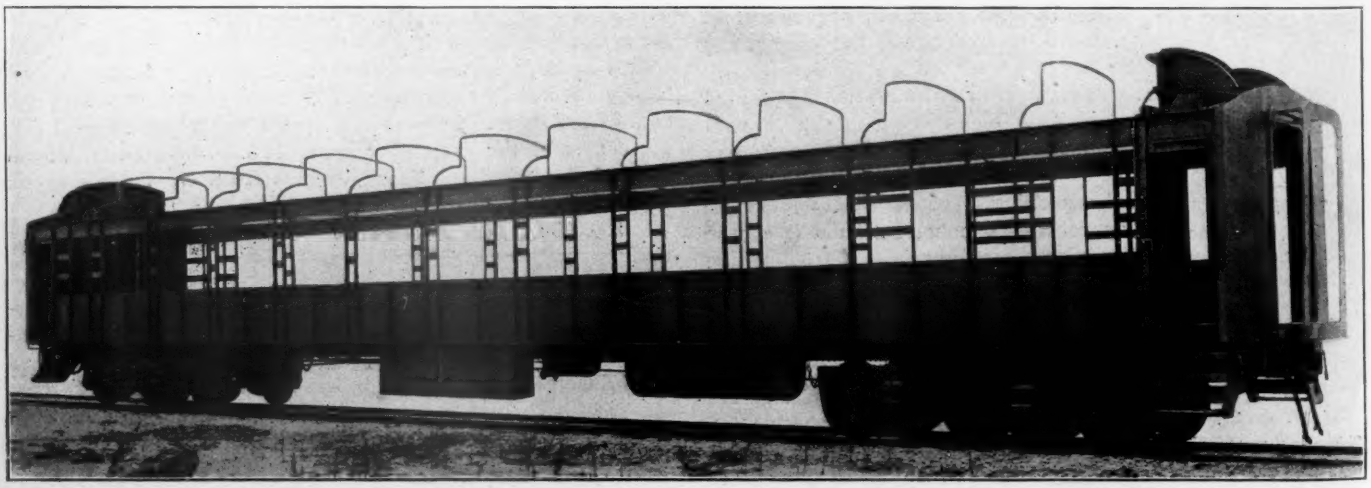
**Fig. 6—Stress Diagram for Steel Car of the Type Shown in Fig. 5**

It is believed that in main line passenger car construction, where sills less than 12 in. deep at the center are provided, the deflection is such as to require support from the side girders. This is actually the case with many designs of framing and has never resulted in any ill effects on account of the potential value of the side girder, which has a large reserve, as shown in Fig. 6. This diagram has reference to a car weighing, complete, 150,000 lb., the weight of the trucks being 38,000 lb., the lading 9,000 lb. and the body 103,000 lb., and even with such an extremely heavy car the stress is less than 8,000 lb. in the side girder. To assist in this, it is possible to employ wide, continuous cover plates top and bottom of crossbearers, and lateral cantilevers connecting the side girders in a single length.

A casual study of the prevailing methods of design of steel framing for freight equipment shows that deep center sills are not countenanced except where conditions demand. The deep center sill is all very well for a flat car having no side support. Probably the most annoying car in the past has been the wooden flat car, which, when heavily loaded at the center, will rise at the ends, or when subjected to a severe shock will rise in the center. No designer would think of providing deep center sills for a hopper car with high sides; it would be a waste of metal and a useless expense.

It is the function of the center sills, with the draft gear and the buffers, to dissipate the greater portion of impact shocks, leaving under the most difficult circumstances only a small proportion to be withstood by the car body proper. Pulling strains are transferred to the side framing on most cars through the use of diagonal bracing and also by substantial cover plates over bolsters and crossbearers. Great care should be exercised to see that the underframe is designed to resist weaving and diagonal strains, which have a tendency to throw the frame out of square.

It has been recognized for many years that camber is a positive necessity in the formation of any design of girder having a considerable span. This is based on the principle that the compression members, which are normally the upper ones, shall not become tension members, as a reversal of the camber brought about by severe loading would cause



**Steel Framing for a Car Which Has Wooden Sheathing**

this condition and the consequent failure of the structure.

Extremes of design have not been discussed, as it was only the writer's aim to show the most suitable design of frame where steel is to be used. It is believed that the data sheet, Fig. 6, covers a design which is pre-eminently safe, even considering as it does the application of two supply boxes, two sets of batteries weighing one and one-half tons, a complete gas equipment and water raising system in conjunction with a large tank under the car and overhead storage tanks inside; also a superimposed load of 9,000 lb. all with an extreme fiber stress less than 8,000 lb. per sq. in. The frame is light, the total cross section of sides and center sills amounting to 77.23 sq. in. Reference may possibly be made to Fig. 2, which has an area of 70.97 sq. in., but when a car with a steel outside is considered the writer believes that advantage should be taken of the side plate and letterboard construction as a compression member; otherwise this means just so much dead weight.

If a 4 in. by 4 in. by 3/8 in. side plate angle, a 2 in. by 3/8 in. bar, a 13 in. by 3/16 in. letterboard plate and a 2 in. by 3/8 in. bottom stiffener were added to this design, it would increase the total cross sectional area by 13.60 sq. in., making a total of 84.57 sq. in., or result in an increase of 9½ per cent, as compared with the design in Fig. 6.

## EIGHT-WHEEL CABOOSE WITH STEEL UNDERFRAME

BY E. F. GIVIN

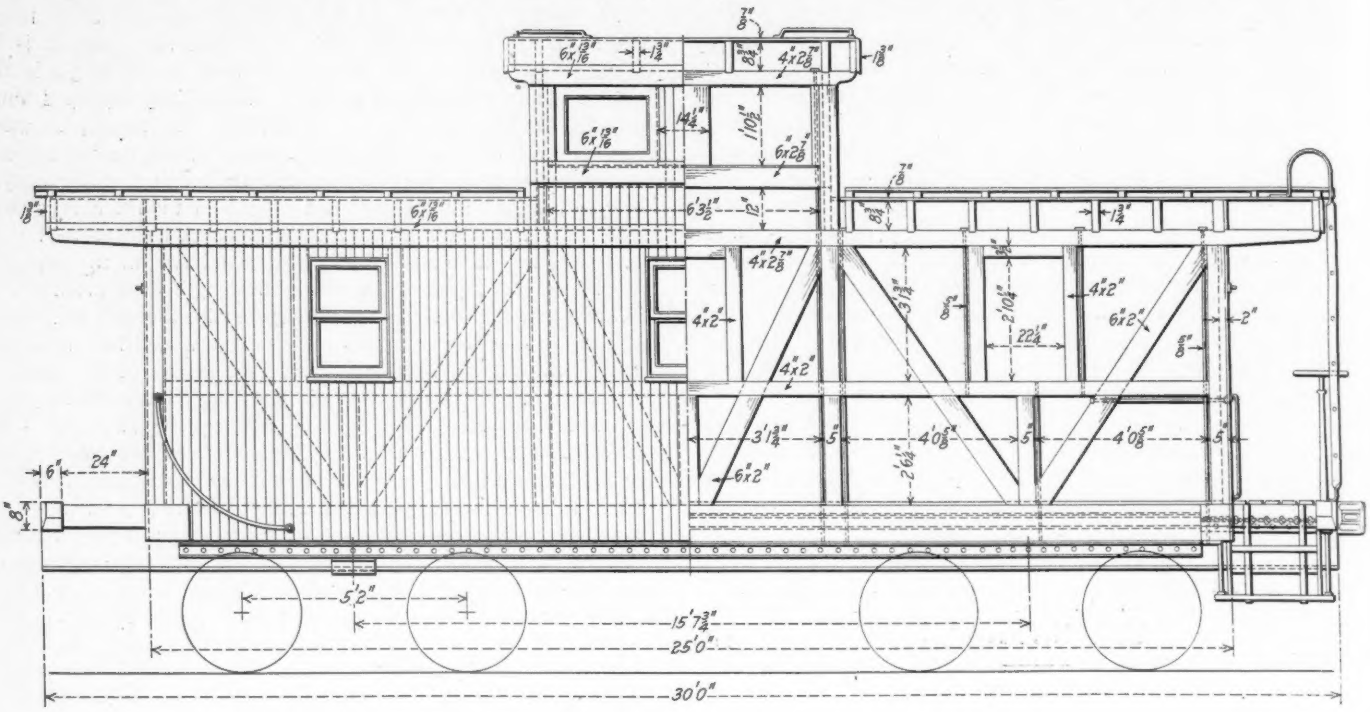
The Pittsburg, Shawmut & Northern has adopted the eight-wheel type caboose as standard to meet the regulations promulgated by the state of New York in 1913 and eight cabooses were built by the Russell Car & Snow Plow Company, Ridgway, Pa., in December of that year, from designs prepared by the mechanical department of the railroad. These cars have now been in service considerably over a year and have given excellent service in heavy trains hauled by four locomotives over grades of from 1 to 3 per cent. The cost of repairs during that time has been very small.

The car is 25 ft. long over the body end sills and 30 ft. long over the platform end sills. The width over the side sills is 9 ft., and at the eaves is 9 ft. 3¼ in., while the inside length is 24 ft. 6⅜ in., and the width 8 ft. 6 in. When fully equipped and ready for service the weight is 36,000 lb. The floor plan was worked out so that cupboards and toilets did not interfere with the window arrangement and the uniform bracing of the body. The length of the car is only one foot greater than that required by the state law, but sleeping accommodations are provided for seven men, five in the body of the car and two in the cupola. The size of the cupola is based on the length of a berth 6 ft. 2 in. long and the seats were so designed that the seat and back cushions on one side could be utilized for a mattress in connection with a berth board which is kept in one of the closets when not in use. The five berths in the body have lockers under them which provide room for tools and supplies and such bed clothing as the crew wishes to carry. Special attention was given to the comfort of the trainmen, owing to their having to occupy the cars for sleeping purposes at outlying points.

The center sills are 15 in.-33 lb. channels placed 12⅞ in. back to back with a 19¾ in. by ¼ in. top cover plate extending between the body end sills. The center sills are in three sections, the main or center section extending to a point 20⅛ in. from the center of the body bolster. The end sections are spliced to the center section by two ½ in. by 21 in. plates and secured in place by twenty-two ⅞ in. rivets through the web and eight ⅞ in. rivets through the top and bottom flanges, cover plates and outside splice plates. The end sections of the center sills are cut to accommodate the body and platform end sills. Top cover plates are used on the end section and extend from the platform end sill to the inner edge of the body end sill. The center sills are tied together at the bottom by three ⅜ in. by 12 in.

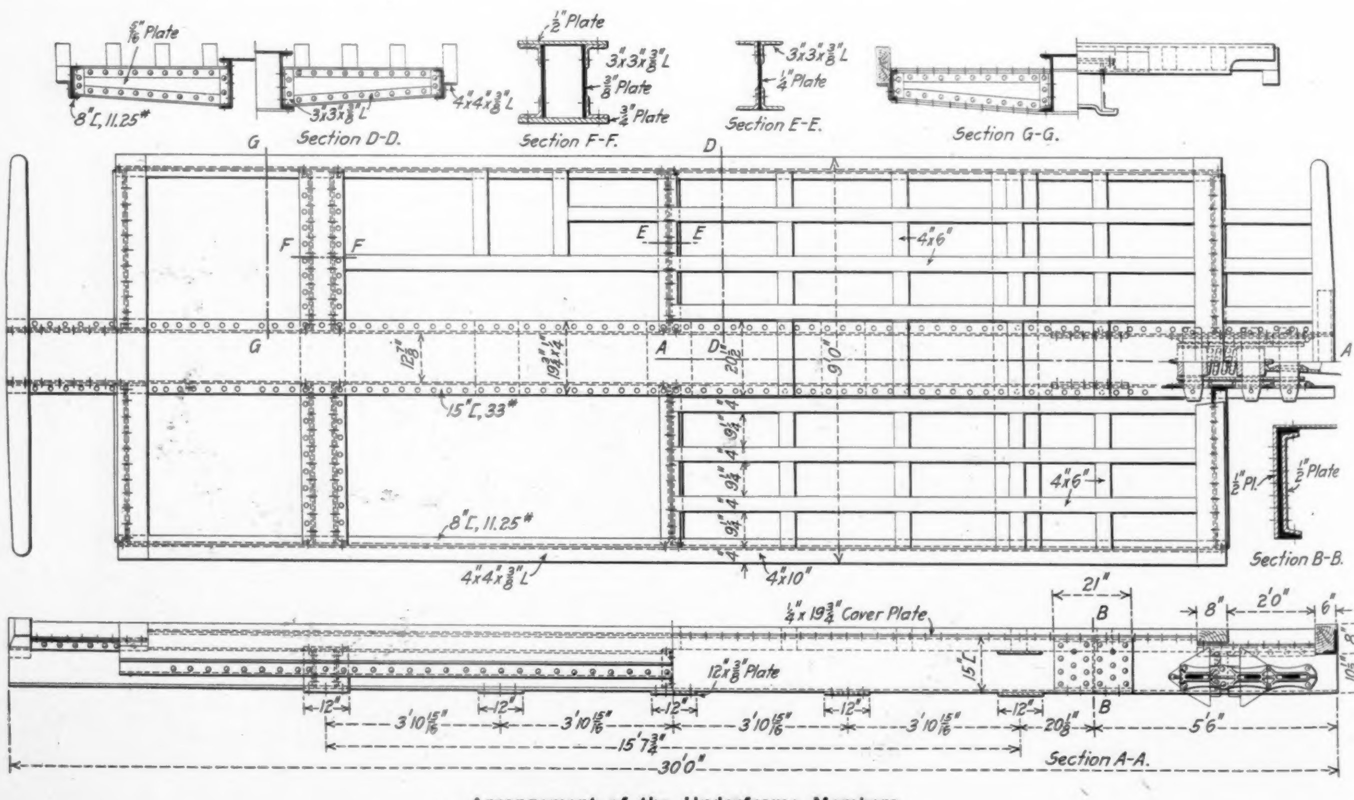

**Steel Underframe Caboose in Service on the Pittsburg, Shawmut & Northern; the Springs Used Are Double Elliptic Instead of the Helical Springs Shown**

plates equally spaced between the body bolsters. The end sections are connected at the bottom by a ¾ in. by 6 in. plate with the ends turned up over the flanges of the sill and fastened by inward. Riveted to the outside of the side sill is a 4 in. by 4 in. by ⅜ in. angle forming a bracket to support a 4 in. by 10 in. yellow pine side sill which mortises into the body end sill of the




**Body Framing of the Pittsburg, Shawmut & Northern Caboose**

four ¾ in. bolts with nuts and cotters. There is also a 4 in. by 1 in. carrying strap turned up over the flanges of the center wooden frame. The end sills are of 5/16 in. plate with 3 in. by 3 in. by ¼ in. angles riveted to both top and bottom on the out-




**Arrangement of the Underframe Members**

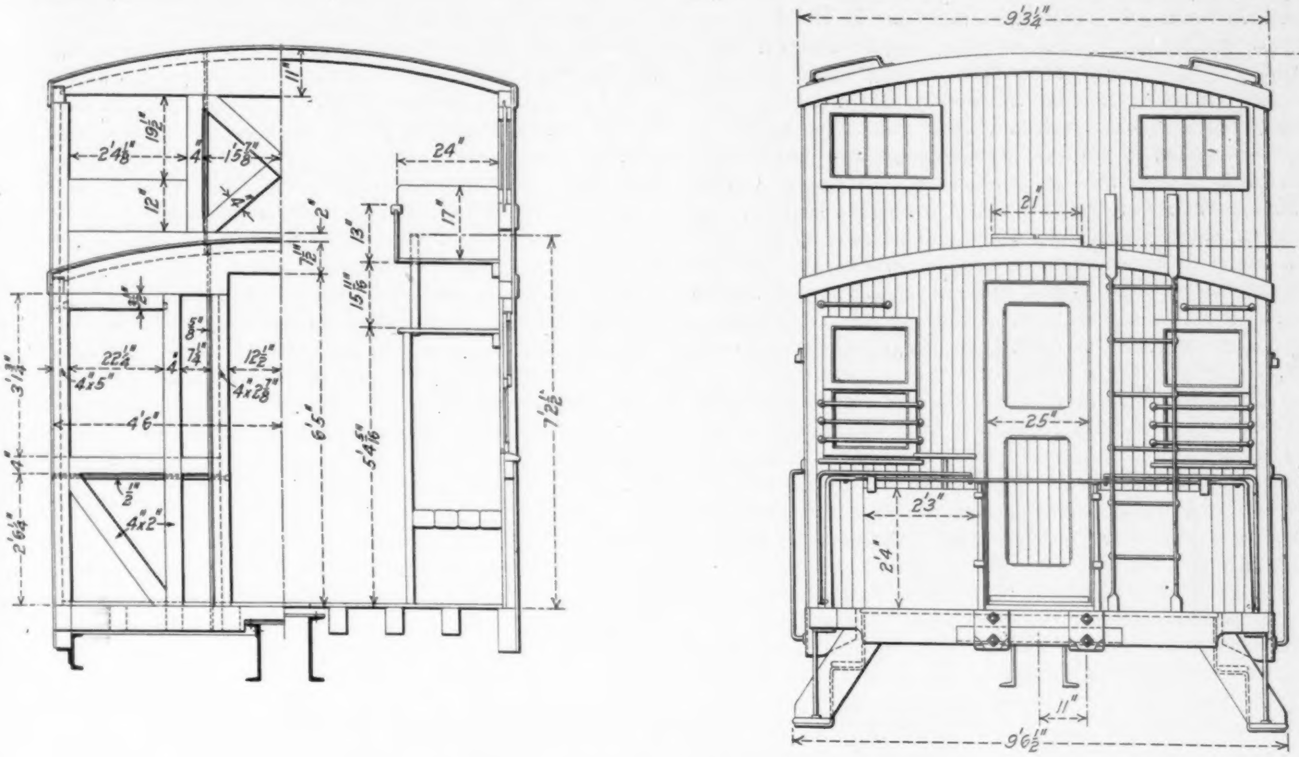
sills, the outside bolts passing through the flanges of the center sills.

There are two side sills consisting of 8 in., 11.25 lb. channels extending between the body end sills with the flanges turned side of the plate. There is a crosstie at the center of the car made of ¼ in. plate with 3 in. by 3 in. by ⅜ in. top and bottom angles on both sides.

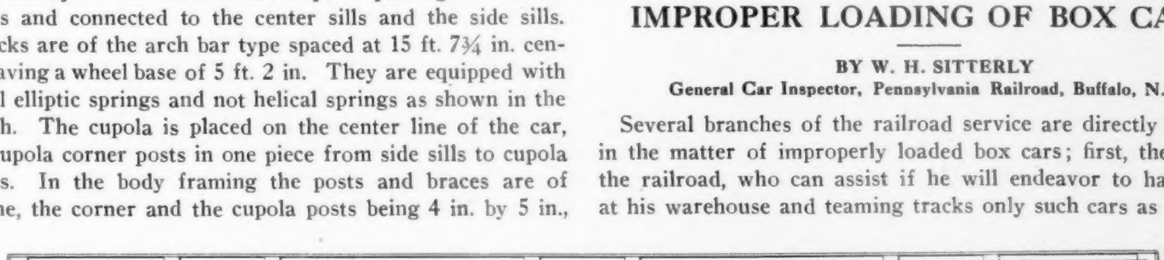
The body bolsters are built up of two ⅜ in. plates placed

vertically and extending between the side and the center sills with 3 in. by 3 in. by 3/8 in. angles, both top and bottom on the outside. They are connected to the center and side sills by 3 in. by 3 in. by 3/8 in. angles on the outside of the plate and have a 1/2 in. by 12 in. top cover plate, passing through the center sills and connected to the top flange of the side sill channels. There is also a 3/4 in. by 12 in. bottom cover plate passing under the center sills and connected to the center sills and the side sills.

The trucks are of the arch bar type spaced at 15 ft. 7 3/4 in. centers and having a wheel base of 5 ft. 2 in. They are equipped with double full elliptic springs and not helical springs as shown in the photograph. The cupola is placed on the center line of the car, with the cupola corner posts in one piece from side sills to cupola side plates. In the body framing the posts and braces are of yellow pine, the corner and the cupola posts being 4 in. by 5 in., while the end and door posts are 2 7/8 in. by 4 in. The belt rail is 2 in. by 4 in. yellow pine and the body end plates are 2 7/8 in. by 12 1/2 in. oak. The body side plates are 2 7/8 in. by 4 in. yellow pine, while the carlines are of oak, 1 3/4 in. by 2 1/2 in., cut to a radius of 16 ft. on the upper edge. The roof is 13/16 in. by 3 1/4 in. yellow pine, tongued and grooved, running lengthwise of the car and covered with canvas roofing. The special equipment includes Buffalo Brake Beam Company's M. C. B. No. 2 brake beams, Simplex truck bolsters, New York air brake equipment, Gould couplers, Acme uncoupling device and Farlow draft rigging.



Cross Sections and End Elevation of the Shawmut Caboose




Floor Plan of Steel Underframe Caboose Used on the Pittsburg, Shawmut & Northern

## IMPROPER LOADING OF BOX CARS*

BY W. H. SITTERLY

General Car Inspector, Pennsylvania Railroad, Buffalo, N. Y.

Several branches of the railroad service are directly interested in the matter of improperly loaded box cars; first, the agent of the railroad, who can assist if he will endeavor to have loaded at his warehouse and teaming tracks only such cars as are fit for loading. A strict observance of the inspector's shop marks on the car by his subordinates will be the means of the defective

*From a paper presented before the Car Foremen's Association of Chicago and re-read before the Niagara Frontier Car Men's Association, Buffalo, N. Y., January 20, 1915.

car moving to the shop repair track instead of receiving a load and then moving to the shop for repairs before it is placed in a train, thereby reducing the revenue that the company should receive for transporting the commodity to its destination. Proper stowing of some commodities in the car by the agent's forces will prevent their coming in contact with the doors en route.

I believe that every car man can recite cases where cars have been loaded at the freight station and teaming siding to be delivered to a connecting line, the line making the switching movement receiving but $3 for such movement and paying to the receiving line from $4 to $20 for a transfer or readjustment of the lading. Instead of the line which made the switching movement receiving a profit from each haul, it was assessed a large amount of money above the switching charge. This also applies to a load where the destination is on the line where the car was loaded. Instead of being placed in the first train and moving to destination, it makes a shop track movement; a large amount of money is spent on it due to defects, reducing the amount of net revenue.

There is another feature to be taken into consideration besides the money lost in the immediate case, and that is a dissatisfied shipper. He expects the commodity to reach his customer on a certain date and it does not, for the reason that the car makes a shop track movement with the load and is delayed in transit from 24 to 48 hours, and in some instances longer. This is particularly bad in a competitive district.

I have found in a great many instances where I have investigated cases of delays and claims for damage that cars bearing inspector's shop marks have been moved from the distributing point to the loading point and loaded. At the time of collecting the cars for distribution, some time of course was saved in *not* switching out the defective car. One department saved some time, but did the railroad in the end save or lose money? The answer is clear.

A group of thirty photographs taken in one of the large yards recently shows the condition of the lading in closed cars. They give a very good idea of the poor loading and the absence of doorway protection. In every instance, the initial road or the road loading the car was at fault in not seeing that the load was properly placed in the car and if necessary doorway protection added. The initial road was not assessed with the cost of rearrangement and the application of doorway protection, but the second or third road handling the commodity had the revenue reduced very materially.

A number of cases of bad loads originate at stations where there is no inspector located and the agent passes judgment on the load. Not being thoroughly conversant with the rules he has insisted on the misapplication of the rules, where if he had taken the matter up with his superior officer and requested the services of a car inspector or other representative thoroughly conversant with the rules, the load would have been properly loaded, the shipper satisfied and the load would reach its destination much sooner, passing by a repair yard instead of into it for adjustment or possibly transfer.

It is the duty of every railroad to educate the shippers located on its lines in the proper method of loading material, both in open and closed cars. This can be done very easily by furnishing the industrial plants with a copy of the Master Car Builders' loading rules and delegating a representative of the railroad who is thoroughly familiar with them to instruct the shipper. I have had considerable experience along this line and while I have met with some objections from shippers, the majority have shown a willingness to co-operate with the railroad company in the proper loading and securing of their commodity so as to insure its reaching its destination safely and without delay. Co-operation of the railroads along these lines at large terminals is absolutely necessary and what are the demands of one railroad as to loading, if in strict accordance with the Master Car Builders' loading rules, should be the demands of each railroad in that district. In this manner, improper loading will be reduced to a minimum. It is, however, absolutely necessary that the representative who is delegated to impart the information to the shipper be thoroughly conversant with the loading rules, as I have found in some cases that inspectors or other railroad representatives have insisted on the shipper using a certain rule which did not apply to the particular load.

In a large district, it is surprising the number of foreign cars that are held in the shop and transportation yards awaiting disposition from the owner on account of their physical condition. I can safely say without fear of contradiction that a large percentage of these cars started away from the loading point carrying a load and it was necessary to shop the cars and transfer all or part of the lading in order to make repairs. In some cases the car never reached the destination intended with the load, the load going forward in another car.

During the past year I have had occasion to watch the physical condition of the box car, which I must say is deplorable. Box or house cars are placed on the shop tracks, and sheathing and siding renewed over posts and braces which are split and in a great many instances posts are decayed at the base or ends. The car receives a load, bulges at the sides and ends, and claims frequently result from loss or damage. I refer particularly to the time of the year when the demand is great for box cars for moving grain out of lake ports.

At one of the large terminals I made a check for a few days and the accompanying table shows cars shopped on account of apparently improper loading, causing bulged doors, shifted loads, etc. Instead of showing the names of the roads, I have used a numeral to represent them.

| Road | Total cars | Total days delay | Per diem expense | Cost, material and labor | Total cost | Avg. cost, material and labor | Avg. cost, material and labor per day | Avg. cars per day | Avg. No. days delay per car |
|---|---|---|---|---|---|---|---|---|---|
| 1... | 13 | 36 | $10.15 | $18.02 | $28.17 | $1.39 | $2.17 | 0.4 | 3 |
| 2... | 296 | 395 | 106.05 | 296.18 | 402.23 | 1.00 | 1.35 | 10.0 | 1.3 |
| 3... | 39 | 45 | 15.75 | 34.68 | 50.43 | .89 | 1.30 | 1.0 | 1.2 |
| 4... | 67 | 110 | 38.50 | 44.12 | 82.62 | .66 | 1.23 | 2.2 | 2 |
| 5... | 104 | 205 | 61.95 | 211.54 | 273.49 | 2.03 | 2.63 | 3.5 | 2 |
| 6... | 11 | 42 | 11.90 | 18.12 | 30.02 | 1.65 | 2.73 | .3 | 4 |
| 7... | 10 | 8 | 2.80 | 4.14 | 6.94 | .41 | .70 | .3 | 1 |
| 8... | 20 | 22 | 6.65 | 13.68 | 20.33 | .68 | 1.01 | .6 | 1.1 |
| 9... | 18 | 18 | 4.20 | 18.06 | 22.26 | 1.00 | 1.23 | .6 | 1 |
| 10... | 4 | 4 | 1.40 | 3.42 | 4.82 | .85 | 1.20 | .1 | 1 |
| Total. | 582 | 885 | $259.35 | $661.96 | $921.31 | $1.14 | $1.62 | 19 | 1.6 |

When working under an agreement, as in the Niagara district, the delivering line passes a car on in order to expedite the movement of freight, which to my mind is not expediting it because it does not make any difference whether a car of this kind lies two days in "A" road's yard for transfer or adjustment, or whether it lies in "B" road's yard for two days.

It has been found that at points where a car inspector is not located, loads are often unevenly distributed in cars through the ignorance of the loader and also due to the agent not understanding the absolute necessity for a proper distribution of the lading, and a number of derailments have resulted from this cause.

A large number of railroads are placing in service new 80,000 and 100,000 lb. capacity box cars and frequently the first load they receive is fertilizer, hides, oil and tar in barrels, destroying the car for the loading of high class commodities. Many car department men have undoubtedly seen this class of car loaded in this way, and adjacent to the car an old empty 60,000 lb. capacity car perfectly fit for the load of hides.

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Railless Tram Cars.—After being in use for only a few weeks, the system of railless cars, which was started in Shanghai by the Shanghai Tramway Company, has, it is announced, had to be suspended for the time being. The only road traversed by the vehicles was the Fekien road, and when everything was promising well it was found that the road foundations were in such a weak condition as to be unable to stand the weight of the cars. The only way for the service to be retarded is for the road to be concreted.—*The Engineer.*

# TESTS OF EXHAUST VENTILATORS

## Conducted to Determine Operative Efficiency; Comparison Between Laboratory and Service Tests

BY GEORGE L. FOWLER
Consulting Mechanical Engineer, New York

During the past winter an investigation was conducted to determine the operative efficiency of the Standard exhaust ventilators used on the passenger equipment cars of the New York Central. Prior to this the only data available as to their operation was that obtained in laboratory experiments conducted by the makers, the Standard Heat & Ventilation Company of New York, to determine the ratio existing between the velocity of the wind blowing over the ventilator and the volume of air that would be exhausted by the action of the ventilator. This data will be referred to later.

The Standard exhaust ventilator is pressed from sheet steel and its general outside appearance is that of a quadrilateral pyramid with one side removed. Its base, which is open, is bolted to a side opening in the deck of the car. Its bottom is the side removed and the shape is such that when air is moving past it, either parallel to the center line of the car or at an angle thereto, an induced current is produced, flowing out at the open side. As this opening communicates directly with the interior of the car, through the base, this induced current is supplied by the air within the car and the exhaustion of this air follows, coupled with the ventilation of the car itself.

The purposes of the investigation were to ascertain the quantity of air removed from the car per hour, under the ordinary conditions of service; the rate of the exhaust removal of air at various speeds, so as to obtain the percentage of efficiency as compared with the results of laboratory investigation, which latter may be regarded as the theoretical or highest efficiency; the effect of wind direction; the effect of the location of the ventilator on the car, or the car in the train; the movement of the air currents within the car; the variation in barometric pressure within and without the car, and the amount of air delivered at the breathing zone.

The car selected for the purpose was a standard steel passenger coach of the New York Central lines. It was 69 ft. 4 in. long inside and had a seating capacity for 84 passengers and a cubic content of about 5,160 cu. ft. The car was fitted with twenty Standard exhaust ventilators, ten on each side, alternating with plain perforated metal deck opening screens of which there were eleven on each side. Both deck and exhaust openings could be closed by a Cheeny deck sash. The deck openings measured 28½ in. by 8¾ in. The exhaust openings were trapezoidal in form and had a free opening of 54½ sq. in., or .378 sq. ft., which was reduced by the dial of the anemometer placed in front of them to .359 sq. ft. No screen or netting was used with them.

#### INSTRUMENTS

For the purposes of the investigation the car was equipped with a vane anemometer, registering to 100,000 ft. of air flow, placed in front of each of four of the exhaust openings on each side. There was one at each end exhaust, with the other two spaced equally between, which made one for each third ventilator.

A cup anemometer of the regulation government type, was placed on the center of the roof of the car deck on the outside. It was arranged to make and break an electrical circuit for each one-tenth of a mile of the flow of the wind. This electrical circuit was arranged to operate a telegraph sounder by which a signal was given for each one-tenth of a mile of flow of air over the roof of the car.

A Boyer speed recorder was attached to one of the axles of the car, and the wire to the indicator was led up into the car. This made it possible to observe the speed at any instant and also retain a graphical record of the speed of the whole run.

A wind vane of standard government dimensions was placed on the center of the deck roof, in line with the cup anemometer, but at the other end of the car. The stem from this vane extended down into the car and had attached to it a pointer rotating over a dial, thus indicating at all times the angle at which the wind was blowing against the car, as a resultant of its own normal motion and that of the car.

A clock was arranged to make and break an electrical circuit at two-minute intervals. This was connected with a bell which sounded a signal for the taking of readings.

The apparatus used for the determination of the variation is barometric pressure, inside and outside the car, consisted of a wooden box, measuring 7 in. by 7 in. by 8¼ in. In each of five of the six sides of this box, eight holes were bored. These were each 5/16 in. in diameter and were widely scattered over the sides. In the sixth side a hole was bored large enough to admit the insertion of a rubber tube having a bore ⅜ in. in diameter. One end of the tube thus communicated freely with the interior of the box, while the other end was attached to one leg of a U-tube, which was half filled with colored water. The box was bolted to a board which replaced one of the deck opening screens. The small holes opened to the outside air and the rubber tube led down to the U-tube within the car, one leg of which was open to the air inside the car. It was thought that the air entering the box through the small holes, and under the influence of the pressure, would have its velocity greatly reduced by the relative sectional area of the box to that of the holes; that it would be so essentially calm as to produce no effect either for exhaust or pressure at the end of the tube, and that the barometric pressure within would be that of the external air, uninfluenced by the motion of the car. The areas were to each other as about 80 to 1, so that air entering the box at the highest recorded wind velocity, even though unchecked by passing through a rough hole 5/16 in. in diameter and 1 in. long would move through at a rate of less than one mile an hour.

#### MOVEMENT

The car, so equipped, was handled on regular passenger trains for one round trip between Albany and Buffalo; two round trips between Albany and Syracuse, and one round trip between Albany and Weehawken, a total distance of 1,466 miles. With one exception the trains were express. Between Albany and Buffalo six intermediate stops were made westbound, and sixteen eastbound. Between Albany and Syracuse there were fifteen westbound and twelve eastbound. Between Albany and Weehawken, there were thirty-four southbound and ten northbound.

#### OBSERVATIONS

Readings at two-minute intervals were made of the speed of the train, the velocity of the wind relative to the car and the direction of the wind relative to the car. At fifteen-minute intervals readings were taken of the anemometers in the exhaust openings, and at intervals between these readings observations were made of the rate at which air moved through the exhaust openings. The readings for these observations were taken at 15 and 30 seconds intervals, the time and speed

of the train being also noted. From the time at which the observations were made it was possible, by means of the two-minute readings, to determine the velocity of the wind relative to the car.

### AMOUNT OF AIR REMOVED PER HOUR

The amount of air removed from the car per hour was determined by the regular readings of the anemometers placed in the exhaust openings. The individual readings were widely scattered, but, when grouped and gathered under averages of speeds increasing by increments of five miles an hour, they were found to increase with the speed, and show, as would be expected, that the amount of air removed varied with the speed. The amount of air removed from the car under observation, in the eight runs involved, averaged 296,699 cu. ft. for each of the eight ventilators to which anemometers were attached. If this total is divided by the number of hours that the car was under observation, which was 41, we have an average removal of 7,236 cu. ft. of air per ventilator per hour. This covers all speeds and conditions of operation from standing still to 76 miles an hour. The average speed of all the trains between terminals was 35.7 miles per hour, elapsed time.

The rate of the removal of the air through the exhaust ventilators was obtained by taking readings of an anemometer, placed at one of the openings of an exhaust ventilator, at such short intervals of time, and in connection with the actual speed of the train at the instant, that it was possible to determine the actual rate at which the air was removed at different speeds of train and wind. During the whole period of these investigations, there was little or no wind stirring. The result was that wind velocity relative to the car corresponded very closely to that of the car itself.

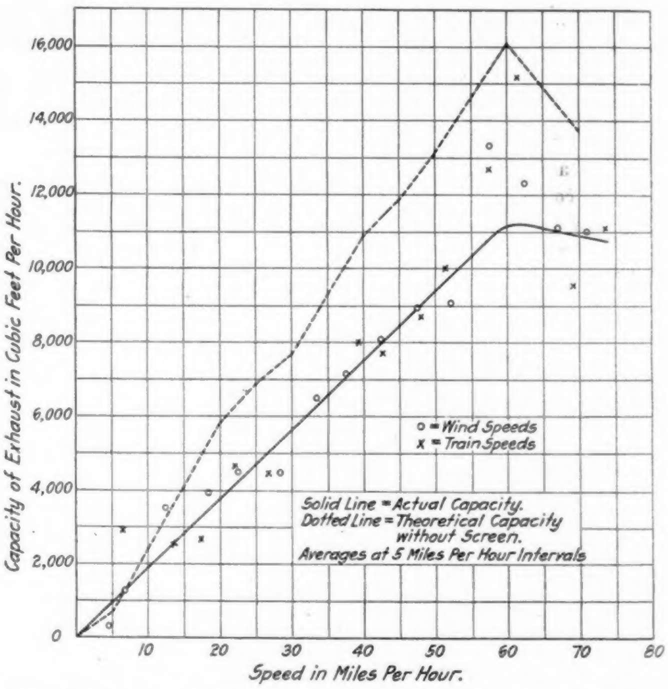
The readings referred to were taken at intervals of 15 or 30 seconds, and at speeds that ranged from zero to 75½ miles an hour for the speed of the train, and from zero to 72 miles an hour for the speed of the wind relative to the car. There were 201 of these observations, and they have been grouped together in five-mile intervals of speed and plotted in the accompanying diagram, under the average speeds. The anemometer readings, thus obtained, have been taken to indicate the rate of flow of air through the ventilator at the several observed speeds, and this has been considered to have been uniform throughout the whole area of the exhaust opening. This is warranted by the results of laboratory investigations, in which it was found that, when the direction of the wind currents was parallel or nearly parallel to the center line of the car, the rate of exhaust flow was uniform over the whole area of the ventilator opening. This diagram shows a general progressive increase in ventilator capacity on a straight line up to 60 miles an hour of train and wind speed. In this case, the train and wind speeds being so nearly the same, it is impossible to differentiate between them in the construction of the median line.

For the purposes of comparison the diagram of the ventilator capacities obtained in the laboratory is plotted with those obtained in service. In the case of the laboratory investigation the capacities given are those obtained with the air moving parallel to the center line of the car, and it is interesting to note that there was a steady increase of capacity directly as the speed up to 60 miles an hour, followed by an immediate falling off as that speed was exceeded.

Owing to the absence of wind during the tests the direction of the resultant wind relative to the car indicated only a slight deflection. The average for all of the runs was but 9.35 deg., and it was near this point that the vane stood for most of the time. For this reason it is fair to compare the ventilator capacities obtained in practice with those of the laboratory, as is done on the diagram. If a comparison is made of the relative capacity of the ventilator under the two conditions, it will be found that up to a speed of 60 miles an hour the efficiency in service was about 70.5 per cent of the theoretical capacity of the ventilator, as measured by the laboratory experiments.

For the purpose of making a practical application of these results, let us take the figures already set forth as an example of what was done on the eight runs under consideration. In these we have an average performance per ventilator of removing 7,236 cu. ft. of air, and that at an average speed of 35.7 miles an hour, and under widely varying conditions from standing still to a speed of 76 miles an hour. According to the diagram each ventilator should remove about 6,700 cu. ft. of air per hour. The actual performances through a wide range of conditions check very closely, therefore, with those obtained from a detailed study of an individual ventilator. As the line of the diagram is straight from 0 to 60 miles an hour, the capacity of the ventilator varies directly with the speed, and may be obtained by multiplying the latter by 188.

Again, if we take the average speed of the train during elapsed time from the start to the last reading of the anemometers, and credit each anemometer for the removal of an amount of air corresponding to the elapsed time and the average speed of the train in accordance with the diagrams presented, it will be found that, according to that diagram, each ventilator should have removed 282,797 cu. ft. of air. Comparing the two, we find the average actually removed was 4.9 per cent more than that calculated with the diagram as a base. Hence the diagram may be assumed to represent the conservative capacity of the ventilator, as this small percentage of variation is well within that allowable.




**Capacity of Standard Exhaust Ventilator as Determined by Laboratory and Service Tests**

### EFFECT OF LOCATION

During the course of the investigations the car was placed in different positions, from being next to the engine to the seventh in the train. It will be readily understood that the data available from so small a number of runs is too meagre to make definite conclusions possible; but what there is indicates that the location of the car in the train does have an effect on the operation of the exhaust ventilators. In order to determine this it was necessary to consider both the amount of air exhausted and the speed of the train. In this I have taken the total amount of air exhausted and prorated it among the eight ventilators that were fitted with anemometers. This gives the average rate of operation for the car.

According to the diagram the amount of air exhausted varies directly with the speed, so that by dividing the average amount of air exhausted by the average speed of the train a quotient will be obtained that may be called the base unit of the operation of one ventilator for the particular run under consideration. If we take the averages of all readings and plot them in accordance with the location of the car in the train we find that there is a slow falling away in total capacity as the car is moved back from the engine; until for the seventh car, it is about 14 per cent less than for the first.

The effect of ventilator location on the car is also noticeable. By taking the ventilators, fitted with anemometers in pairs, as they were opposite each other, and averaging each pair for the several trips, it appears that, going back from the front, there is a steady fall in efficiency from the first to the third, with a rise for the fourth.

This indicates that the ventilators at the forward end of the car are most efficient, and that there is a falling off in efficiency at the middle of the car and a rise again towards the rear.

### MOVEMENT OF AIR CURRENTS WITHIN THE CAR

Careful observations were made of the movement of the air currents within the car. This was done by means of smoke produced at the points at which it was desired to make observations. The doors and windows of the car fitted closely in their frames. At the cracks of the doors there was never sufficient air movement to operate an anemometer, though a coolness could always be detected. Also in the body of the car below the seven-foot line above the floor, no air currents of sufficient intensity to operate an anemometer could be detected at any time. The anemometer explorations were, therefore, all made in the deck space.

When the car was running at 60 miles an hour, an anemometer placed at the back end of the deck opening, which was 5 ft. 6 in. from the end of the car, showed air velocities of from 180 to 575 ft. per minute when the opening was at the front end. One-quarter of the way across the deck and opposite the opening they were still higher, and when the anemometer was placed close to the ceiling, they ran from 735 to 976 ft. per minute. Out at the middle of the deck, still close to the roof, they fell to from 250 to 440 ft. per minute. As the exhaust was approached on the opposite side of the car, three-quarters of the way across, the velocities increased again to from 600 to 680 ft. per minute. Dropping down into the car they ranged from 700 to 835 ft. per minute, even as low as the deck sill, but no movement of the anemometer could be obtained below the line of the parcel rack. This will give an idea of the velocities at which the air entered the car.

Studies of smoke movement showed that, when produced in the deck, it did not come down into the body of the car, but swept along towards the nearest exhaust ventilator and was carried out. When produced below the line of the deck sill it was quickly dissipated, but slowly came down into the car and then took an upward movement towards the ventilators. When produced in the body of the car in the breathing zone, it started at once for the deck, was nearly dissipated when it reached the sash of the ventilators and was then carried out with great rapidity.

On the run from Albany to Weehawken and return, observations were made as to tunnel conditions and effect. It is the practice of the road to close all of the deck openings and, at times, all of the exhaust ventilators, when passing through tunnels, of which there are three of some length. These are known as the West Point, Haverstraw and Weehawken tunnels. There is a fourth and shorter one at Rondout creek, but the locomotive is out of this before the rear of the train has entered.

In the runs under consideration all deck openings and all of the exhaust ventilators to which anemometers were applied, were left open. Immediately upon entering the tunnels, large volumes of dense black smoke rolled in at the front deck openings. The smoke swept back along the roof of the deck and out at the exhausts. None of it came down into the body of the car and none of it was perceptible to the senses, even to those immediately beneath, when it was so dense overhead as to obscure the head lining. This was true not only of the experimental car, but also in the regular working coach occupied by passengers, whose ventilation was regulated to accord with that used in the experimental car itself.

The runs from Albany to Weehawken, on the West Shore, were made with the twofold object of obtaining data as to the action of the ventilators in tunnels and when running alongside a high bank with a free and clear space on the other side of the car. These conditions obtained on the West Shore, where, for long distances, the track is laid along the bank of the river with high, steep banks on the west and the open river on the east.

It was suggested that, under these conditions, it might be possible that eddy currents, created by the normal wind and the movement of the car close to the bank, might be of such a character as to cause the exhausts to act as intakes. Nothing of the kind could be detected. The ventilators invariably performed their true functions as exhausters of the air within the car, whether running in the open, through tunnels or close to a side bank.

### BAROMETRIC PRESSURE INSIDE AND OUTSIDE THE CAR

Under all ordinary working conditions, there was no perceptible difference in the height of the water in the two legs of the U-tube. But, with all deck openings closed, and the 20 exhaust ventilators, with which the car was equipped, open, there was a rise of level on the car side of the U-tube of 1/16 in. when the car was running at a speed of 53 miles an hour, and the wind velocity over the roof was about 54¼ miles an hour, thus showing that, under these conditions, the ventilators were capable of producing a partial vacuum in the car.

### AMOUNT OF AIR DELIVERED TO THE BREATHING ZONE

Attention has already been directed to the fact that the circulation of air through the car, under all conditions of service, was of too quiet and gentle a character to be measured or detected by the delicate anemometers used. That there was a circulation, constant and persistent, is shown by the observations of smoke movements. The means adopted to determine the efficacy and efficiency of this movement was that of taking samples of air from the breathing zone of working cars occupied by passengers. These samples were afterwards analyzed for their content of carbon dioxide.

The method is generally known as that of Pettenkofer and "consists in estimating the vitiation of the atmosphere by determinating the amount of carbon dioxide that it contains, and from this computing the amount of air supplied for ventilation."

For the purposes of calculation it was assumed that each passenger would excrete .6 cu. ft. of carbon dioxide per hour, and that the incoming fresh air was diluted with 4 parts in 10,000 of carbon dioxide. The calculation is, then, simply that of estimating the amount of such air that would have to be supplied, for the time and number of passengers concerned, to produce an atmosphere containing the amount of vitiation indicated by the analyses of the samples taken.

The method of collecting the samples was as follows: Two ordinary cautery bulbs were used for pumping the air into the receiving bottles. The admission valves of the two bulbs were held close together and at arms length from the operator who squeezed them. Their delivery pipes led to the bottom of two clean 8-oz. white-glass bottles. The bulbs themselves had a capacity of about 4 oz. This method insured the delivery of the samples of air to the bottom of the bottle and the forcing of the previous contents out at the neck. In accordance with the practice and recommendations of the Bureau of Mines the

bulbs were squeezed at least fifty times in the collection of each sample. The use of two bulbs delivering to two separate bottles was merely to secure two samples as nearly identical as possible for check analyses in case of doubt or accident.

The samples were collected by walking slowly along the aisle of a working car. Immediately after the collection of the sample the necks of the bottles were closed by the insertion of soft rubber stoppers of the best quality obtainable, and, at the end of the run, these were in turn sealed by dipping in a melted mixture of beeswax and turpentine. Every possible effort was thus made to insure the samples being truly representative of the average condition of the air in the car at the time they were taken. They were all obtained from cars in regular service and the positions of the ventilator openings were recorded.

While the special car was in service, the working coach next to it in the train was used to obtain the air samples, and its ventilators were arranged in the same manner as those of the special car, the only difference between the two being the location of the two cars in the train and its effect on the operation of the ventilators. The effects of this have, necessarily, been neglected.

In a report to the Master Car Builders' Association, in 1908, a committee placed the amount of fresh air that should be supplied for the ventilation of a passenger car at 1,000 cu. ft. per passenger per hour. The results of these tests show that this amount was exceeded in every instance, and that this was accomplished without producing strong air currents or drafts in the breathing zone.

### CONCLUSIONS

The conclusions to be drawn from this investigation are that:

One Standard exhaust ventilator will supply sufficient air to the breathing zone to meet the requirements of four passengers on the basis of 1,000 cu. ft. per passenger per hour. Its capacity varies directly as the speed of the train up to 60 miles an hour. The actual capacity in cubic feet per hour equals the speed of the train in miles per hour multiplied by 188. This actual capacity may be taken to be about 70 per cent of the theoretical rating.

The location of the car in the train has an effect on the efficiency of the exhaust ventilator. Speaking generally, the nearer the car to the engine the higher the efficiency. There is probably no mathematical ratio determinable for this.

The location of the ventilator on the car has an effect on its efficiency. The ventilators near the ends of the car have a higher capacity than those at the center, and those at the front have a greater capacity than those at the rear.

No perceptible drafts are created by the Standard exhaust ventilators below the tops of the windows. There is a gentle movement of the air down into the body of the car, and up to the deck in a complex system of currents, that cannot be differentiated.

Smoke or noxious vapors entering the car at the deck openings do not come down into the body of the car, but are drawn out through the exhaust ventilators.

High banks, cuts or tunnels have no effect on the action of the Standard ventilator.

It is not necessary to close the ventilators when passing through tunnels.

The heating of car near floor is successfully accomplished.

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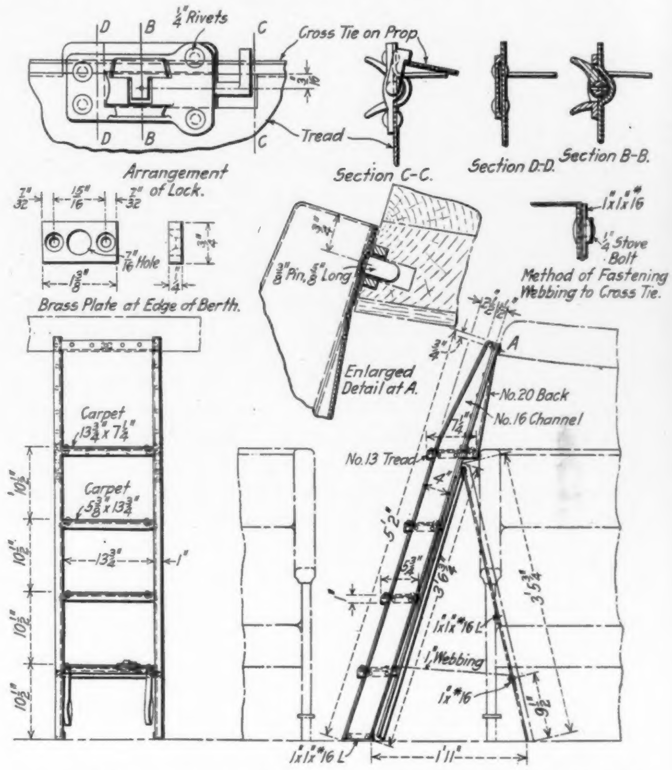
Etching on Glass.—A simple method of etching glass is to coat it with melted candle-grease, and draw the pattern to be etched in the wax with a sharp needle point. Then expose the glass to the action of vapor of hydrofluoric acid, generated by acting on fluorspar with hydrochloric acid, and gently warm. The gas must be generated in a lead vessel, as it attacks most substances. It is very poisonous, and, therefore, care must be taken not to inhale it.—*American Machinist.*

# STEP-LADDER FOR SLEEPING CARS

The engraving shows a light step-ladder which has met with considerable success as an upper berth ladder for sleeping cars on the Canadian Northern. The main frame is made of channels, the folding legs are angles, the treads are covered with carpet and the whole ladder combines lightness with strength. The method of securing the top of the ladder to the berth insures against slipping and possible accident therefrom. The locking arrangement, details of which are shown in the drawing,




**Step-Ladder Used in Sleeping Cars on the Canadian Northern**

is on the back of the tread to which the 1-in. webbing is attached and serves to secure the prop against the ladder when not in use. The space between the top of the ladder and the top tread is completely enclosed at the sides and back. This ladder was developed in the office of A. L. Graburn, mechanical engineer of the Canadian Northern, Toronto, Ont.

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Accidents Due to Poor Lighting.—That fully 25 per cent of the accidents to workmen are caused by insufficient lighting for men working at night, is the opinion of experts who have made a study of the subject. It is estimated that $250,000,000 is the average annual cost of injuries to workmen in the United States alone, and that over 50 per cent of these accidents are preventable.—*Popular Mechanics.*

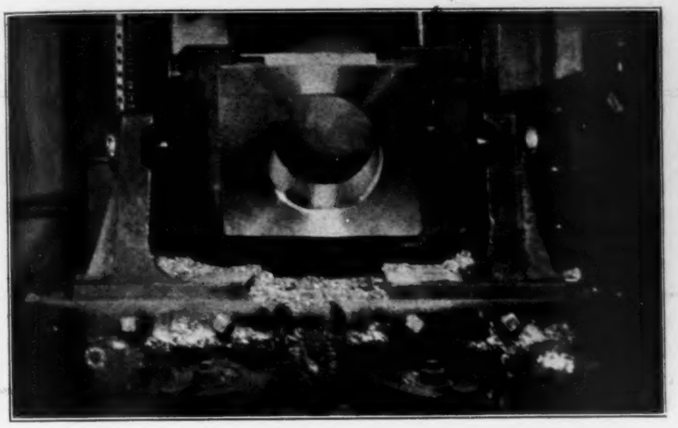
Protecting Metals Against Heat.—A recently discovered process, termed by its inventor "calorization," said to protect combustible metals from atmospheric action at high temperatures and make them available for a much wider range of usefulness than is now the case, was recently described in the General Electric Review. The metals are heated in revolving drums containing, among other things, finely divided aluminum, by which a surface alloy containing aluminum is produced. Pieces which because of their shape and size are not adapted for tumbling, may be calorized by packing them in, or painting them with a suitable mixture and heating them. After iron is calorized, the effect of heating is slight. Instead of burning and the scale falling off, as in the case of untreated iron, practically no effect can be detected.—*American Machinist.*

# SHOP PRACTICE

## BORING AND FACING BACK END MAIN ROD BRASSES AND DRIVING BOXES

BY M. FLANAGAN
**Master Mechanic, Chesapeake & Ohio, Richmond, Va.**

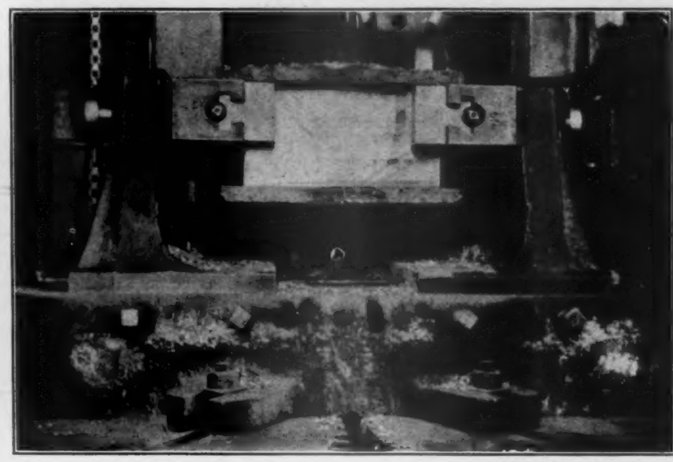
A special chuck for use on a 42 in. Bullard maximill has recently been fitted up at the Seventeenth street shops of the Chesapeake & Ohio, Richmond, Va., for boring and facing back



**Rod Brass Being Reversed After Boring and Facing One Side**

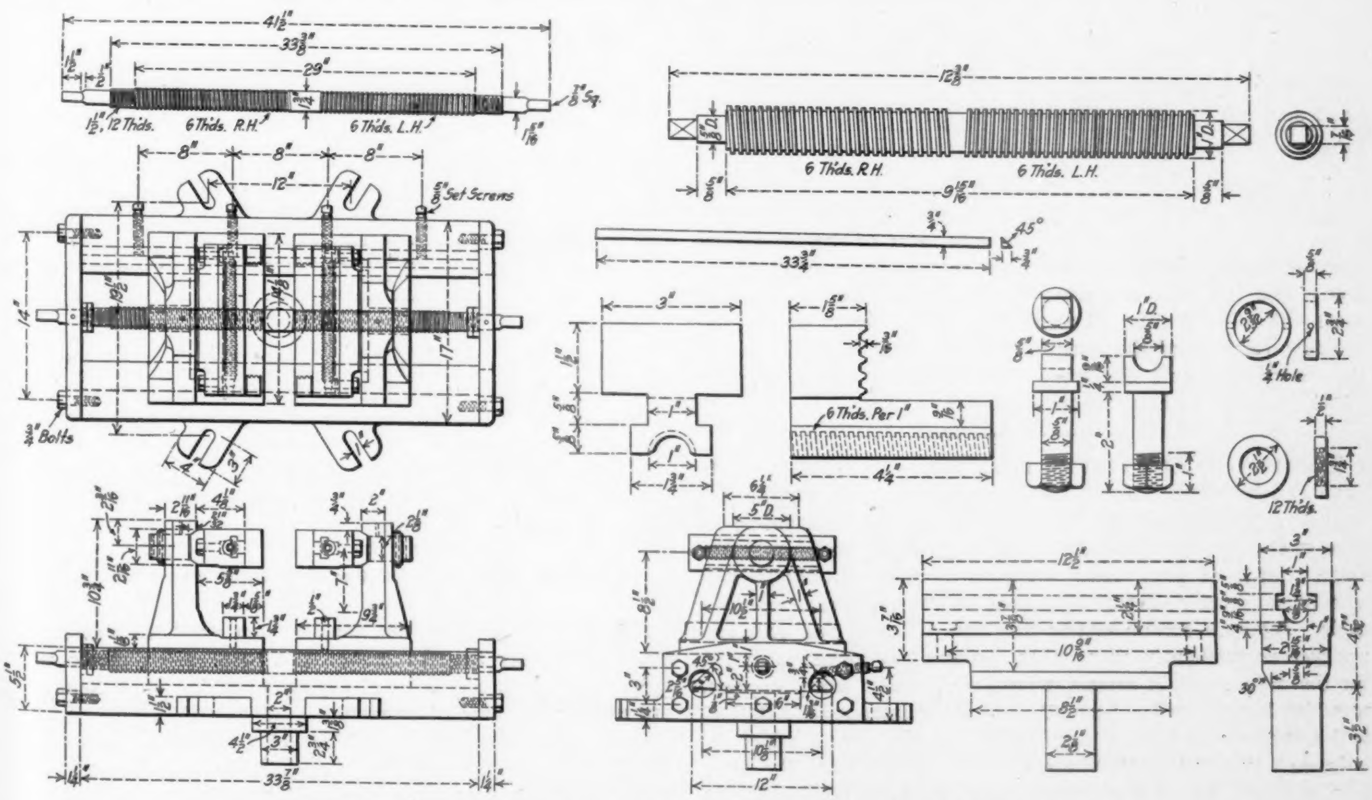
end main rod brasses and driving boxes. The device was designed by Frank B. Moss, general foreman, and since it has been in use, laying out brasses and boxes for boring has been discontinued altogether as the chuck accurately centers and clamps them in line with the inside faces of the flanges.

As shown in the drawing the base of the chuck is centered on the boring mill table by means of a cylindrical projection fitting into the central recess in the table and is secured by four bolts. The main jaws of the chuck are operated by a right and left hand screw in the base and each main jaw is provided with a



**Back End Main Rod Brass in Position for Boring and Facing**

chuck, the horizontal jaws of which operate at right angles to the main jaws. These secondary chucks may be released and revolved through 180 deg., and again accurately located in a horizontal position by the pressure of the work.

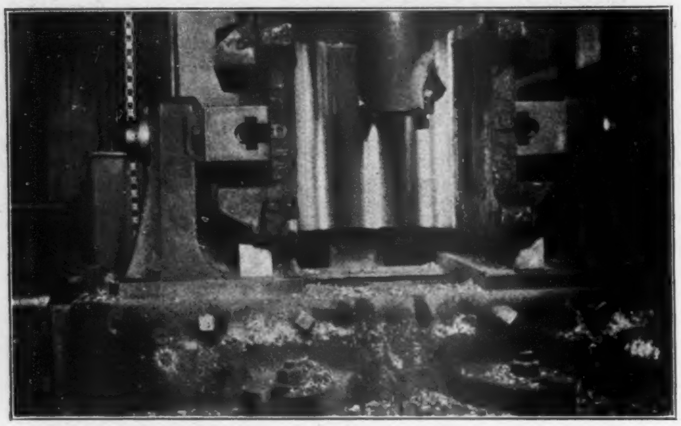



**Details of Self-Centering Chuck for Back End Main Rod Brasses and Driving Boxes**

After having finished the sides and inside faces of the flanges of a pair of back end main rod brasses they are placed in the chuck as shown in one of the illustrations, the universal action of the

chuck jaws accurately centering the brass when they are closed. The brass is then bored and one side faced and filleted. The main jaws of the chuck are then released and the brass, still clamped in the secondary jaws, is inverted. After closing the main jaws the brass is faced and removed.

When finishing these brasses by the old method of laying out, setting up and machining in an engine lathe, about two hours was required on each set, at a cost of 77 cents. By the use of this chuck the total time consumed on each set in the boring mill is about 10 min., and the cost of doing the work has been reduced to 6½ cents per set. In the accompanying table is given



Driving Box Chucked for Boring and Facing

a record of the time expended in the various operations, from the time the brass leaves the floor until it is finished and again placed upon the floor. The time given is in minutes:

| | Time chucking. | Time rough boring. | Time finish boring. | Time facing first side. | Time filleting. | Time turning over in chuck to face second side. | Time facing off second side. | Time chuck to floor. | Time floor to floor. |
|---|---|---|---|---|---|---|---|---|---|
| First brass.. | 2 | 2½ | 1½ | 1 | ½ | 1 | 1½ | 1 | 11 |
| Second brass | 2 | 2 | 1½ | 1 | ½ | 1 | 1 | 1 | 10 |
| Third brass. | 2 | 2½ | 1½ | 1 | ½ | 1½ | 1½ | 1½ | 12 |
| Fourth brass | 1½ | 1½ | 1 | 1 | ½ | 1 | 1 | 1 | 8½ |
| Fifth brass.. | 1½ | 1½ | 1½ | 1 | ½ | 1½ | 1 | 1 | 9½ |
| Sixth brass. | 1½ | 1½ | 1 | 1 | ½ | 1 | 1 | 1½ | 9 |

Average total time per brass, floor to floor, 10 min.

When used for boring driving boxes the secondary jaws and screws are removed from the revolving faces of the main jaws and the latter clamped against the shoe and wedge faces of the box. The box is thus centered between the shoe and wedge faces and may be adjusted along the vertical center line to suit the requirements of the brass. The time used in laying out is thus eliminated and the total cost of boring and facing the boxes is reduced about 50 per cent.

Variations in Locomotive Performance.—An article recently published by one of our contemporaries calls attention to the troubles attendant on the variations in locomotive running in that engines of the same class, hauling similar loads, over the same stretch of line, under identical running conditions, will sometimes show a disparity in running that is almost inexplicable. Again, a certain engine may run badly on one occasion, and yet do brilliantly on another, without any apparent reason for the difference. A certain driver, also, with a heavy express, to which his engine has been attached at an intermediate station, will make every effort to regain time, for the loss of which he is in no way responsible, whereas another driver, with the same type of engine and a lighter train, under similarly late conditions of running, will be content to adhere strictly to his schedule throughout. Such variations in locomotive running are the hardest of all to explain, as it is difficult to believe that there can be any difference in the constructional work sufficiently great to account for them.—*The Engineer.*

# PIECE WORK AND BONUS SYSTEMS IN THE BOILER SHOP

**BY N. H. AHSIUOLH**

The fundamental purpose of both piece work and bonus systems is to increase the ratio of output to time consumed. It has been proved that this result can be successfully accomplished in locomotive boiler repair shops by either system and still turn out a high grade of work. The personal efficiency of the individual workman which is necessary to accomplish these results is frequently not developed, however, due to the lack of proper facilities, or to their improper arrangement, and to the lack of interest among foremen and their immediate superiors.

The foreman must take an active interest in the earnings of the men and should know approximately how each man or each gang of men is working. If they are falling below the earnings which they may be expected to make he should learn the reason and take steps to remove the causes of the reduced output. Where the men feel assured that the foreman is thus interested and that they may always expect fair treatment they will have a greater interest in their work and will accomplish much better results than would otherwise be possible.

In any efficiency system the efforts of the workmen are measured in units of output, and where he is paid on this basis the workman's interest is naturally to increase his output as much as possible, at times even at the expense of proper workmanship. The judgment of the individual is used to a greater extent in boiler repairs than in any other line of locomotive work, and the foreman must therefore be continually on the alert to see that good judgment is exercised and that the increased output does not result in any slighting of the work.

Under an efficiency system there are always some jobs that do not pay well no matter how great the efforts to increase the

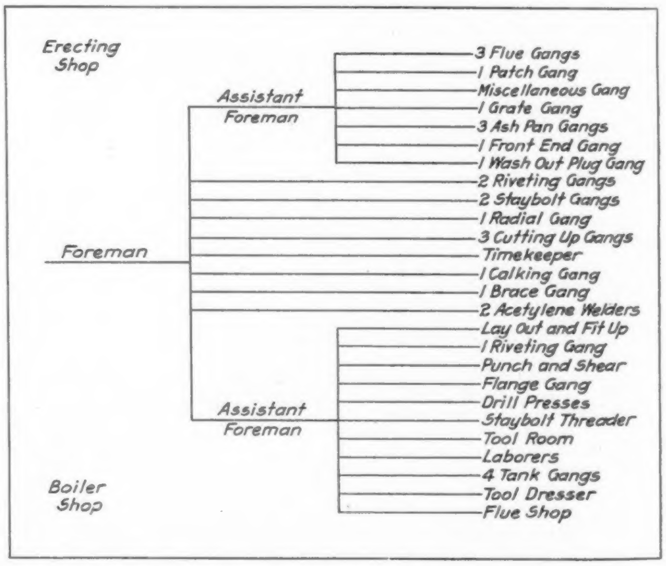



Fig. 1—Organization of a Boiler Shop Under the Bonus System

output. It is difficult to get men to stay on these jobs and to equalize matters the writer has had occasion to divide them among men who are on good paying work, but such conditions are usually a source of friction.

Fig. 1 represents the organization of a locomotive boiler shop which the writer has handled under a bonus system for several years. This organization is composed of a large number of small specialized units. The small units are required by the bonus system because bonus payments are based on individual effort and no provision is made for pooling workmen into a number of larger units as is done in piece work shops.

A portion of the force is divided into regularly assigned boiler

shop and erecting shop boiler gangs whose work is confined to their respective shops, the balance of the force being placed in either shop by the foreman as required. The staybolt gangs apply staybolts in both shops. The cutting up gangs remove fireboxes in the boiler shop and tube sheets, door sheets, etc., in the erecting shop. This division of the force into a large number of small units increases the difficulty of supervision as compared with a force of larger gangs, each in charge of a gang leader.

In the following table are given the operations into which the erecting shop boiler work is divided, together with the names of the gangs handling the different operations. With the exception of the riveting and flanging gangs each gang is made up of two men who perform but one or two operations on each boiler, the gangs following each other in the order shown:

| | |
|---|---|
| 1—Remove grates | Grate gang |
| 2—Remove ashpan | Ashpan gang |
| 3—Remove front end | Front end gang |
| 4—Remove back tube sheet | Cutting up gang |
| 5—Remove front tube sheet | Cutting up gang |
| 6—Remove staybolts | Cutting up gang |
| 7—Remove radials | Radial gang |
| 8—Flange tube sheets | Flange gang |
| 9—Fit and drive back tube sheet | Riveting gang |
| 10—Fit and drive front tube sheet | Riveting gang |
| 11—Apply braces | Brace gang |
| 12—Apply radials | Radial gang |
| 13—Apply staybolts | Staybolt gang |
| 14—Apply washout plugs | Washout plug gang |
| 15—Apply tubes | Flue gang |
| 16—Calk hydrostatic test | Calking gang |
| 17—Apply ashpan | Ashpan gang |
| 18—Apply grates | Grate gang |
| 19—Apply front end | Front end gang |

During the year 1914, with an average of 68 men working 55 hours per week the output of the larger jobs involved was as follows:

| | |
|---|---|
| Staybolts renewed | 28,948 |
| Fireboxes applied | 17 |
| Back tube sheets applied | 26 |
| Door sheets applied | 4 |
| Radial stays renewed | 8,946 |
| Crown bar bolts renewed | 2,043 |
| Half side sheets applied | 4 |
| Three-quarter door sheets applied | 5 |
| Tubes removed and replaced | 30,608 |
| Front tube sheets applied | 19 |
| Boiler patches applied | 155 |
| Firebox patches welded | 26 |
| Firebox patches lapped | 24 |

This work was done in a shop having few facilities, the boiler shop machinery consisting of one set of 10-ft. rolls, two drill

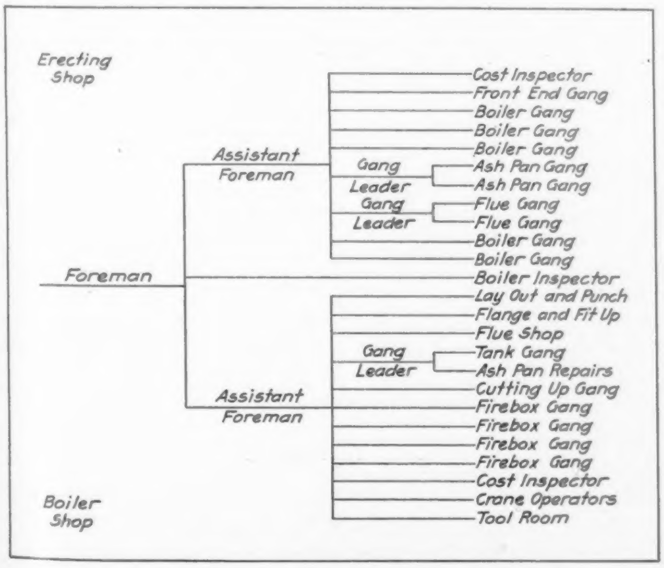



Fig. 2—Organization of a Piece Work Boiler Shop

presses, one punch and shear having a 28-in. throat, one staybolt threader, one hand clamp, one flanging forge and a set of air clamps. The boiler shop contains a few home-made jib cranes for handling fireboxes and there are no cranes in the erecting shop, an engine hoist being provided to wheel the engines.

All riveting is done with air hammers, and all staybolts and radials are driven with air hammers. Careful attention is given to the fitting of work before riveting. Tube sheets and door sheets are fitted into place with acetylene gas burners, and when riveted it is never necessary to calk the seams; on firebox renewals the seams are never calked on either water or fire side. No rivets are allowed to be driven until the foreman has inspected the various seams and determined that the fit is absolutely metal to metal. The extra time thus required is more than justified by the time gained in riveting, and when the hydrostatic test is applied very few leaks are found. Considering the absence of facilities and the comparatively high earnings of most of the men the cost of work is low in this shop. Staybolts in new fireboxes are applied for about eight cents each complete and mud ring rivets for six cents each. Back tube sheets are fitted and riveted complete in the erecting shop for $20 each.

The oldest of the so-called efficiency systems is the straight piece work system, which is now in use in several railroad shops. The organization of a piece work boiler shop is shown in Fig. 2. When a firebox job arrived in this shop the cutting-up gang dismantled and removed the old firebox and, if necessary, the front tube sheet. The new sheets went first to the laying-out and punch gangs and were next turned over to the flange gang. The latter flanged and fitted up the new fireboxes, and where necessary the shell sheets. The work was then delivered to the firebox gang, who riveted and calked the firebox, riveted and calked the shell sheets, put the firebox in the shell, applied the mudring, staybolts, radial stays and front tube sheet, completing the boiler work ready for the tubes. The boiler was then generally taken to the erecting shop where the tubes were applied by the tube gang.

The erecting shop boiler work was handled by gangs of about five men each. These gangs each did all the work required on a single boiler, with the exception of the tubes, ashpans and the front ends, which were handled by specialized gangs. The duties of the cost inspectors shown in the organization chart were to write all piece work slips for the jobs as they were completed.

The pooled units in this shop being of a comparatively large size and the number a minimum, proper supervision was not difficult. The foreman could follow the output and earnings of each gang, and therefore was enabled to keep a better grasp on the situation in this shop than in the one referred to in Fig. 1. This organization was a complete success, and all the men made good money and turned out excellent work. Its special feature was the assigning of a gang of from five to seven men to one boiler on which it handled all the work, including the riveting, staybolt work, tube sheets, etc., the gang doing the work being responsible for the calking required on the hydrostatic tests. As a result there was a friendly rivalry among the different gangs which stimulated the men to do both the maximum amount and the best quality of work at all times. This incentive to do good work was a very important factor contributing to the success of the organization viewed from an efficiency standpoint. There was always a race to see which gang would get its boiler or firebox completed in the quickest time and to see which could turn out the tightest work, requiring the least calking in the hydrostatic test.

These gangs were made up of two boilermakers, one or two handy men, one or two helpers and a rivet boy. As the opportunity presented itself the helpers and handy men were promoted and given corresponding increases in pay. This is of great assistance in keeping the organization of a boiler shop intact. With no prospect of something better in the future, men are constantly quitting, and high efficiency cannot be obtained where it is necessary to be continually hiring and breaking in new men.

Of the two systems the straight piece work system is the better where a steady class of labor is available. But in many localities, where the right kind of labor is hard to secure and much harder to keep, the bonus system is the better because it guarantees an hourly rate regardless of the workman's efficiency.

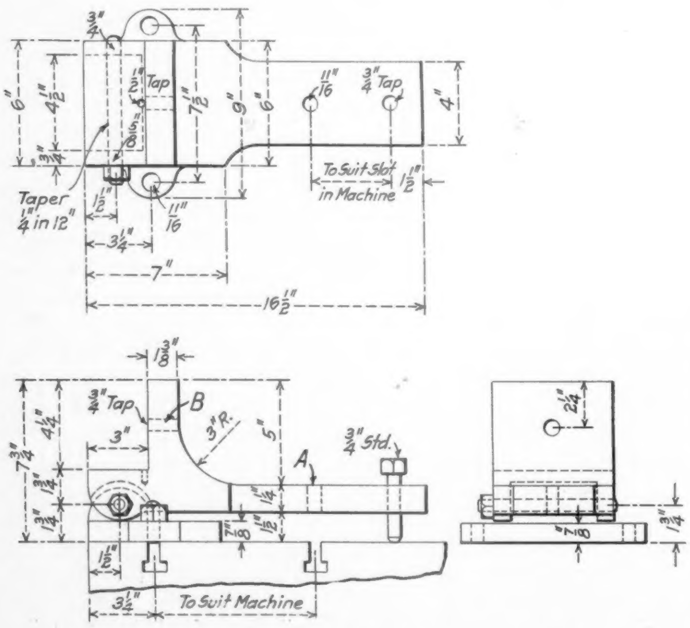
The bonus system is much more complicated than the piece work system and is less apt to be thoroughly understood by the men in the shop. If the piece work price for calking 100 rivet heads is $1, and a man calks them in 2½ hours, he immediately knows that he has made $1 in 2½ hours; but in a bonus shop it requires considerable calculation to arrive at the earnings for any particular job.

It is a poor efficiency system which permits a boiler shop to turn out a boiler after a general overhauling, supposed to run from 18 to 20 months, in such a condition that within 3 or 4 months the roundhouse boilermakers are beginning to calk tube sheet flanges, renew leaking rivets in side sheet patches, renew staybolts in the fire line which were broken before the engine was shopped, and other work which should have been taken care of while the engine was in the shop. The intelligent determination of the repairs which are necessary and the careful supervision of the work while under way are most important considerations in the handling of a piece work or bonus shop. The foreman and his assistants and the boiler inspector must have a knowledge of the repairs required on each boiler in ample time to plan for the work before the boiler reaches the shop.

## JIG FOR GRINDING GUIDE BARS

BY R. E. BROWN
Machine Shop Foreman, Atlantic Coast Line, Waycross, Ga.

A very simple device for lining up guide bars on a grinding machine is shown below. It consists of a base clamped to the table of the machine with two bolts and a guide rest pivoted to the base by a long taper pin. Two of these jigs are used, one under each end of the guide bar. The guide bar is first clamped to the guide rests, the set screws on the ends being loosened to clear the table at least ¼ in. The guide is then squared up by adjusting one of the set screws, the other being then turned down until it touches the table. The guide rests are then rigidly




Jig for Setting Up Guides on Grinding Machine

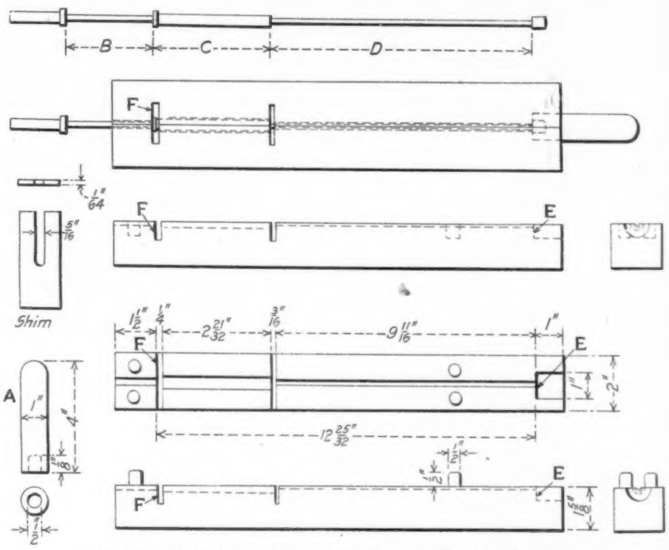
secured by means of bolts at *A* and the guide lined up longitudinally by set screws in the tapped holes *D*.

This device eliminates the cut-and-try method of setting guides which is necessary when they are clamped directly to the table. By its use an experienced operator is enabled to change guides in about two minutes; and this is possible whether or not the guides are sprung, as the jigs automatically adjust themselves to this condition. These jigs have been used at this point for about two years with excellent results, the output having been increased 50 per cent.

## REPAIRING WORN AIR PUMP REVERSING RODS

BY J. A. JESSON

The device shown in the drawing is used for upsetting worn 9½ in. air pump reversing rods and for straightening those which are bent. It consists of two steel blocks, grooves in which enclose the reversing rod when the blocks are placed together. The blocks are held in alinement by means of the dowel pins shown in the illustration. When a worn rod is to be repaired it is first heated at the button end and placed in the blocks which are then clamped tightly together. The set *A* is inserted over the button head in the 1 in. recess at the end of the blocks and with a couple of blows of the hammer the button is driven against the shoulder *E* at the inner end of the recess. The same operation drives the collar between the rod sections *B* and *C* against the shoulder *F* in the blocks. The distance between shoulders *E* and *F* is such




Dies for Upsetting Worn Air Pump Reversing Rods

that the rod is by this means restored to its original length. Should the rod at section *C* be too short it can readily be drawn out by swedging close to its end, and any bend in the rod may be straightened to conform to the groove.

Occasionally when repairing a rod so small in diameter that it will spring in the groove instead of closing up properly, the shim shown in the drawing is inserted in the slot between the collar on the rod and shoulder *F*. This holds the button end away from the shoulder at the end of the block far enough to compensate for the tendency to spring. The set fits closely in the recess in the block, and holds the button head in alinement during the upsetting operation.

COPPER AND WARFARE.—The magnitude of the estimated consumption of copper in the warfare in Europe is astounding. An English estimate of the copper consumption by the German and Austro-Hungarian armies is at the rate of 112,000 long tons per annum; a German estimate places the consumption at the rate of 100,000 metric tons per annum. The estimates are in close agreement and, therefore, probably accurate. If the Teutonic allies are consuming 100,000 metric tons per annum, their opponents must be using a quantity that is at least as large, which would indicate a total of 200,000 tons, or 20 per cent of the world's maximum production. At present the rate of production is materially less.—*American Machinist.*

# FACTORS IN HARDENING TOOL STEEL*

## Structural Changes Due to Heating; Quenching Mediums; Effect of Mass; Furnace Conditions

BY JOHN A. MATTHEWS and HOWARD J. STAGG, Jr.†

In this paper we shall confine our attention to carbon steels, together with some consideration of so-called special steels containing various alloys, usually below 3 per cent. We shall consider the subject, also, from the basis of sound well-worked materials, confining our attention to the hardening operation.

Carbon forms at least one definite compound with iron, $Fe_3C$, known as cementite. This is the hardest constituent in steel. Cementite exists in annealed steel associated with a perfectly definite quantity of iron, or ferrite, as it is metallographically known. This definite relation between ferrite and cementite yields the constituent pearlite, in which the cementite and ferrite may exist in a laminated or a granular condition. This aggregate contains a definite percentage of carbon, 0.89 per cent, and steel containing 0.89 per cent carbon in its normal condition, is found to consist of nothing but pearlite when examined microscopically. In steel containing less than 0.89 carbon the cementite associates with sufficient ferrite to form pearlite, and leaves the excess ferrite free in distinct microscopic grains or crystals. On the other hand, if the steel contains above 0.89 carbon, there is more cementite present than can become associated with ferrite, and the excess being unable to find a partner, so to speak, exists in separate particles, either granular or in a more or less perfect net work surrounding the pearlite. The definite percentage of carbon which yields a full pearlite structure in the annealed or natural condition is known as the eutectoid composition. Steels of lesser carbon are called hypo-eutectoid, and steels of higher carbon are called hyper-eutectoid steels.

When carbon steel is heated above a certain temperature, a change takes place in the constitution of the steel. This temperature is known as the carbon change point, critical temperature, or, preferably as the decalescence point. When this temperature is reached the pearlite becomes austenite, a solid solution of iron carbide in iron. This change occurs at a nearly constant temperature, but in case of hypo-eutectoid steels, the austenite first formed above the decalescence point acts as a solvent for the excess ferrite. In other words, at a somewhat higher temperature than the decalescence point, we obtain a homogeneous solid solution of all the cementite in all the ferrite. This is the best condition for hardening a low-carbon tool steel and accounts for the practice of heating low-carbon steels hotter than hyper-eutectoid steels for hardening. The excess cementite of hyper-eutectoid steels is not readily soluble in the austenite first formed from the pearlite and it requires a high temperature to complete the solution of the excess cementite. Practically considered, nothing is gained by doing so.

Steels quenched quickly from above the decalescence temperature retain the carbon more or less perfectly in the condition of solid solution that existed above the decalescence point. The structural name for the quenched product is martensite. Hypo-eutectoid steels, hardened, may show either all martensite or martensite and ferrite. Hyper-eutectoid steel should show martensite and cementite. Just as in the change of ice to water or of water to ice, there is an evolution or absorption of heat, so is there an absorption or evolution of heat in steel on passing through its critical range.

The permanent changes in dimensions which steel undergoes in hardening are of the utmost interest to the hardener, and associated with these changes is the problem of hardening cracks.

Le Chatelier has studied the phenomena of expansion or dilatation by accurate scientific methods, and has divided the changes into three zones of temperature: Changes at temperatures below that at which allotropic transformation begins; changes at temperatures above those at which allotropic transformation occurs; and changes occurring within the critical range itself. During the first of these periods from 0 deg. to 700 deg. C., iron and steel expand nearly equally, the amount of carbon exerting little influence. For any iron or steel, however, the amount or rate of dilatation increases with the temperature. Below 100 deg. C. the dilatation is about 0.000011 in., while between 600 deg. and 700 deg. C. it increases to 0.0000165 in. per deg. C. Above the critical range, however, the coefficient of dilatation varies directly with the carbon, and is nearly twice as great for a 1.20 carbon steel as for a 0.05 carbon iron. The changes taking place at the decalescence and recalescence points, Le Chatelier has not been able to study so satisfactorily. He has found, however, that the dilatation which increases directly with the temperature up to the decalescence point, suddenly stops and that instead of an expansion, a marked contraction takes place. On cooling steel from high temperatures, these changes in dimensions are reversed, although they are not quantitatively equal, nor do they occur at the same temperatures. The expansion of steel in heating to 750 deg. C. is about 1/8 in. per ft., and when we recall that, in quenching, a corresponding contraction attempts to take place suddenly, it is little wonder that strains are set up that may exceed the ultimate strength of the steel.

After passing through the critical range, the expansion takes place at its maximum rate. When steel is heated above that temperature necessary to harden, it assumes the shape corresponding to the maximum temperature and on cooling the whole piece tends to return to, or near, its original size. In so doing the outer, or first cooled, portion is hardened first and forms a

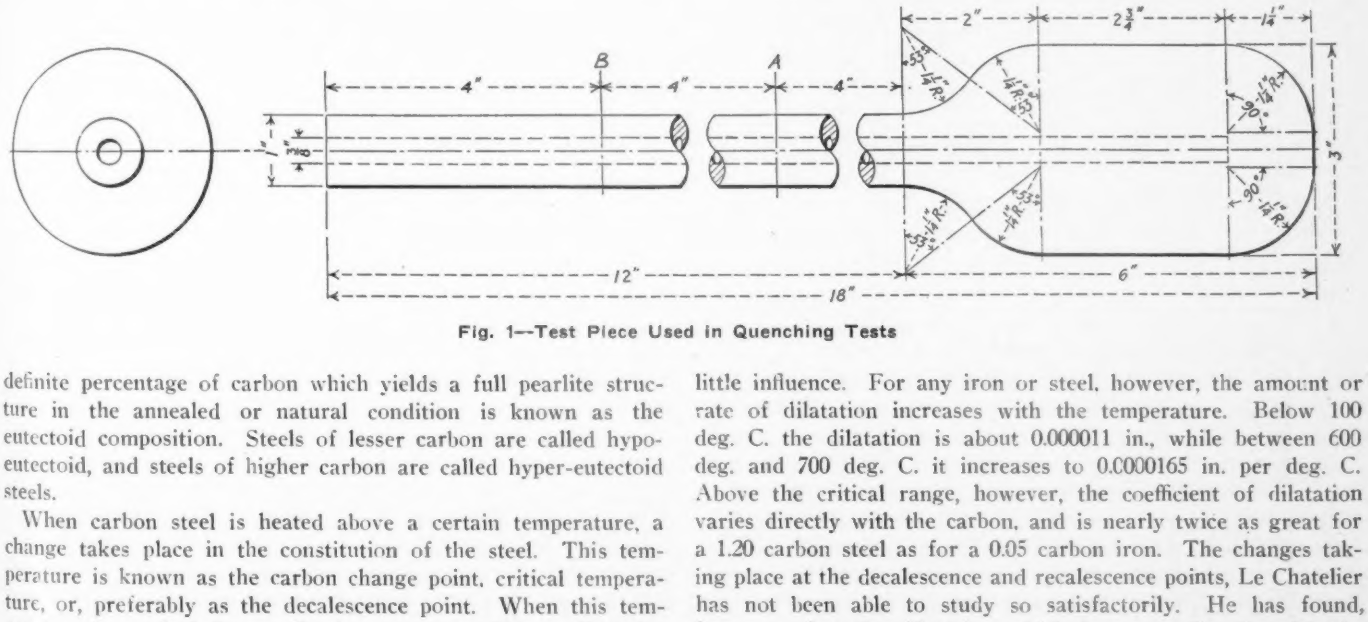



Fig. 1—Test Piece Used in Quenching Tests

*From a paper read before the annual meeting of the American Society of Mechanical Engineers held in New York, December 1-4, 1914.
†Halcomb Steel Co.

hard, brittle, unyielding shell, and the strains set up by the slower cooling interior may either fracture the shell, producing external cracks, especially if the shell be uneven in thickness, or burst the piece at the center if the shell is of even thickness and strength. This latter occurrence is accompanied by a peculiar appearance of the fracture, and is frequently and wrongly called pipe.

*Time of Heating.*—Too much stress cannot be laid on the fact that there is a correct length of time for heating, and that this time of heating is as important as the temperature to which heated. There are at least two dangers which must be avoided. First, if the heating be too fast, a uniform temperature does not exist throughout the mass being heated. For example, a die block heated too quickly may exhibit the following conditions: The outer portions may be above the decalescence point, and expanding at the maximum rate; the intermediate portions

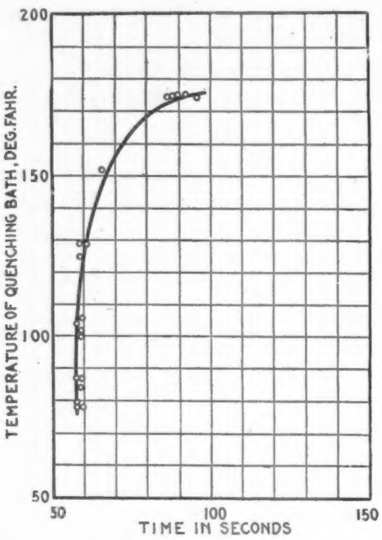



Fig. 2—Quenching Power of Pure Water

may be in the transformation range and contracting; while the inner portion, which is below decalescence, is slowly expanding. What wonder that steel fractures under such conditions?

Second, grain size depends, among other variables, upon temperature above decalescence, and the time such a temperature is maintained. If heating be of such a character that the piece is held above the decalescence point for an abnormally long time, the crystals may have grown to such an extent that on quench-

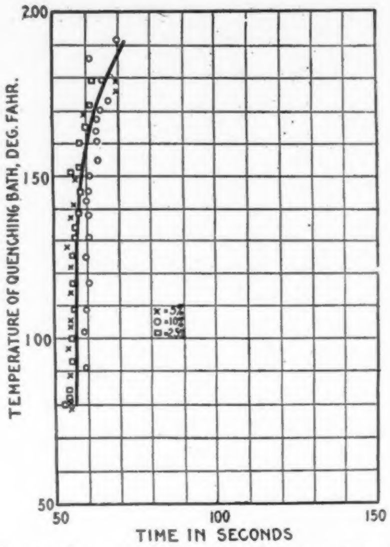



Fig. 3—Quenching Power of Brine Solutions

ing, abnormal grain size is retained and the result is a weak, if not cracked, piece.

Quick heating in a furnace which is considerably hotter than the correct hardening temperature is extremely bad practice. The difficulty is that the thin parts, corners and edges are liable to attain an overheated temperature before the larger portions of the piece attain the correct hardening temperature, and this overheating of the thin parts produces large grain size, abnormal expansion and tends to produce cracks.

*Speed of Quenching.*—If a sample of steel be cooled slowly from above the decalescence point, the solid solution which has been formed breaks up and precipitates its cementite and ferrite, and we have then an annealed steel. If the cooling on the contrary be rapid, the solid solution is not given the time necessary

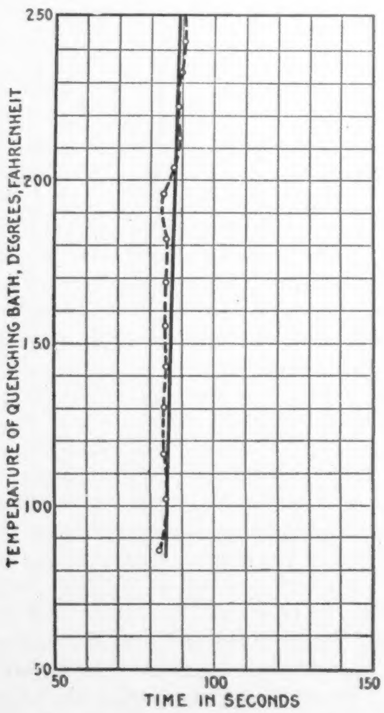



Fig. 4—Quenching Power of No. 2 Lard Oil

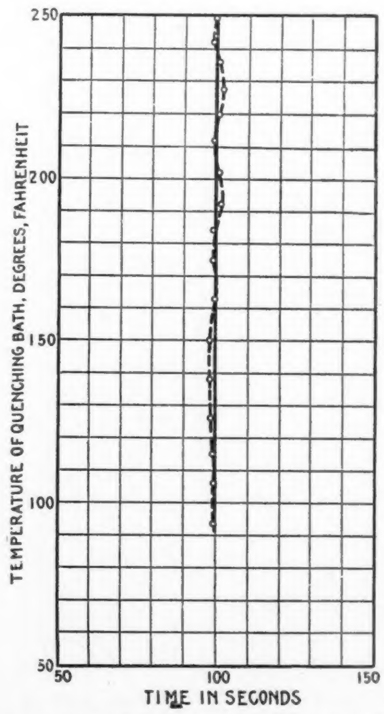



Fig. 5—Quenching Power of Prime Lard Oil in Use Two Years

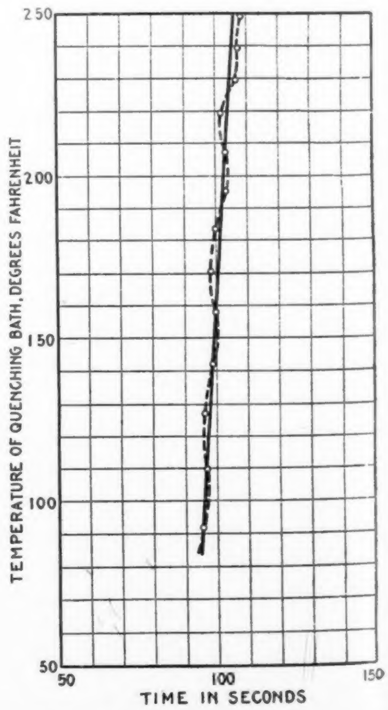



Fig. 6—Quenching Power of Raw Linseed Oil

to permit the complete dissociation into cementite and pearlite, and we find formed the intermediate break down of austenite, known as martensite. If the cooling be intermediate in its speed between extremely slow and extremely fast, we find intermediate microconstituents, troostite or sorbite. The correct

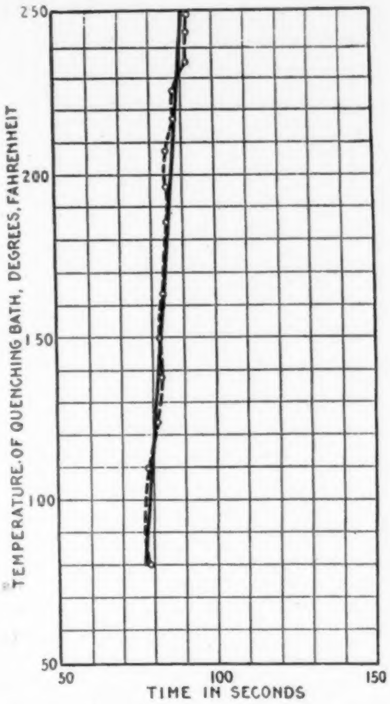



Fig. 7—Quenching Power of New Fish Oil

constituent, however, in a hardened steel is martensite, and to form this martensite the material must be cooled quickly. There are several degrees of "quickness" which at once suggest themselves. There is, however, a critical rate of cooling through the

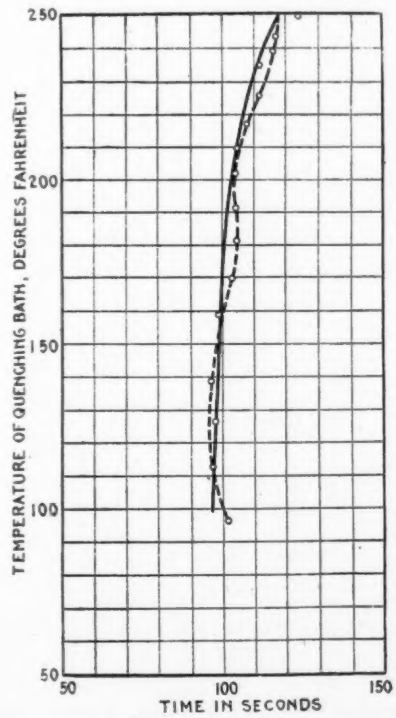



Fig. 8—Quenching Power of New Extra-Bleached Fish Oil

range which must be attained before the piece will be hardened.

On quenching it is clear that the surfaces of the section are cooled and hardened first. If the mass being cooled is of considerable size, different degrees of hardness are noticed from the outside to the middle.

The cooling medium used, its temperature and condition, also affect the rate of cooling. In order that a liquid present in large bulk may exhibit a good quenching power it is necessary that it should possess a high latent heat of vaporization, and that it be maintained at a temperature low enough to avoid too abundant formation of vapor.

In investigating numerous commercial quenching mediums which are in use in typical hardening plants, the following method was adopted by the author: A test piece of the dimensions shown in Fig. 1 was machined from a solid bar, and a hole drilled through the neck to within an equal distance from each side and the bottom of the test piece. Into this hole a calibrated, platinum-rhodium couple was inserted and the leads connected to a calibrated galvanometer. The test piece was then immersed in a lead pot, also containing a thermo-couple, to the point *A*, and the lead pot was maintained at a temperature of 1,200 deg. F. When the couple inside the test piece was at 1,200

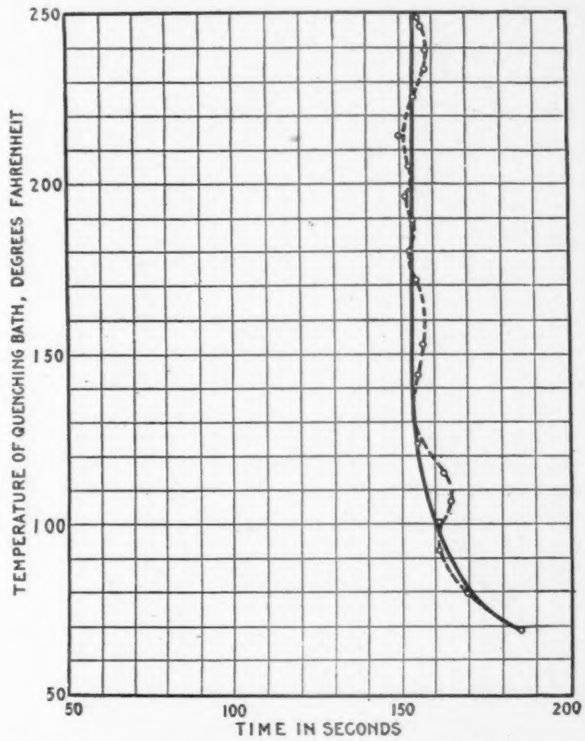



Fig. 9—Quenching Power of No. 1 Dark Tempering Oil

deg. F., and the couple in the lead pot read 1,200 deg. F., the test piece was removed and quenched to the point *B* in 25 gal. of the quenching medium under consideration. At the start the quenching medium was maintained at room temperature. The time in seconds that it took the test piece to fall from a temperature of 1,200 deg F., to a temperature of 700 deg. F., was noted by the aid of a stop-watch. Immersing the test piece in the quenching medium raised the temperature of the medium. The test piece was then replaced in the lead, heated to 1,200 deg. F., quenched in the medium at this higher temperature and the time again taken with the stop-watch. These operations were continued until the quenching media, in the case of oils, had attained a temperature of about 250 deg. F. The results obtained, time in seconds for a fall from 1,200 deg. F. to 700 deg. F., were plotted against the temperature of the quenching medium and a series of curves of the type shown in Figs. 2 to 14, inclusive, were obtained.

A consideration of the results is interesting. Pure water (Fig. 2) has a fairly constant quenching rate up to a temperature of 100 deg. F., where it begins to fall off. At 125 deg. F. the slope is very marked. Brine solutions (Fig. 3) have both

a quicker rate of cooling and are more effective at higher temperatures than water.

As is well known the oils are slower in their quenching powers than water or brine solutions, but the majority of them have a much more constant rate of cooling at higher temperatures than

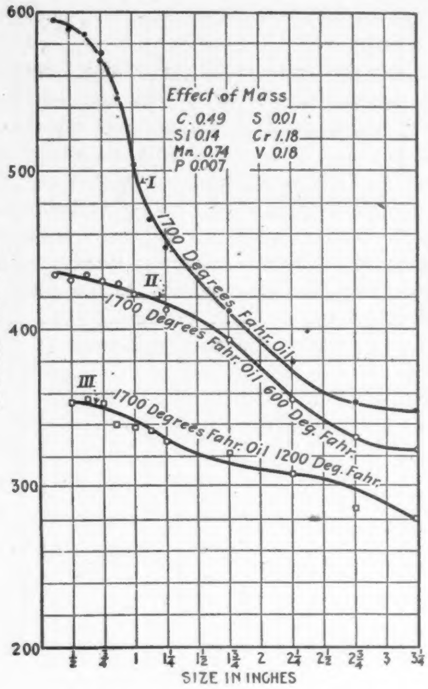



Fig. 10—Chrome-Vanadium Steel Quenched in Oil

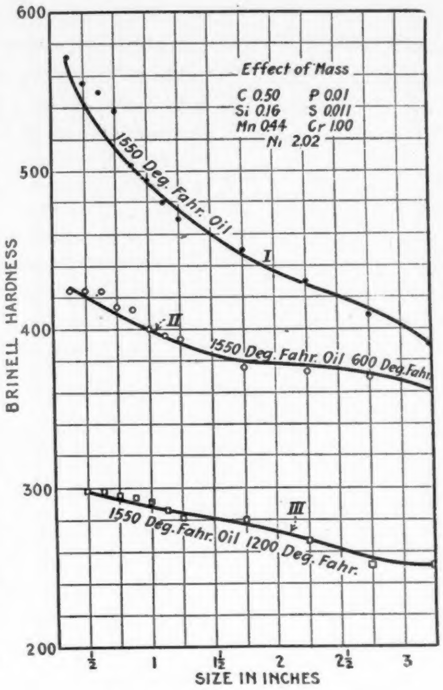



Fig. 11—Nickel-Chrome Steel Quenched in Oil

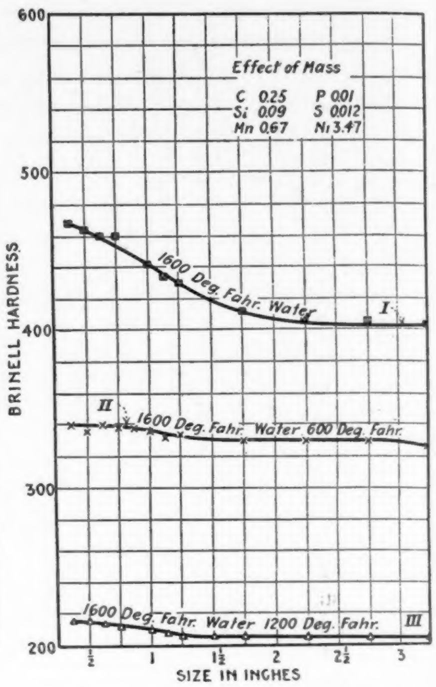



Fig. 12—Nickel Steel Quenched in Water

Effect of Mass Upon Brinell Hardness

water or brine. The curve shown in Fig. 9 is for a thick viscous oil somewhat similar to cylinder oil. It is particularly interesting in that it has slower quenching ability at low tempera-

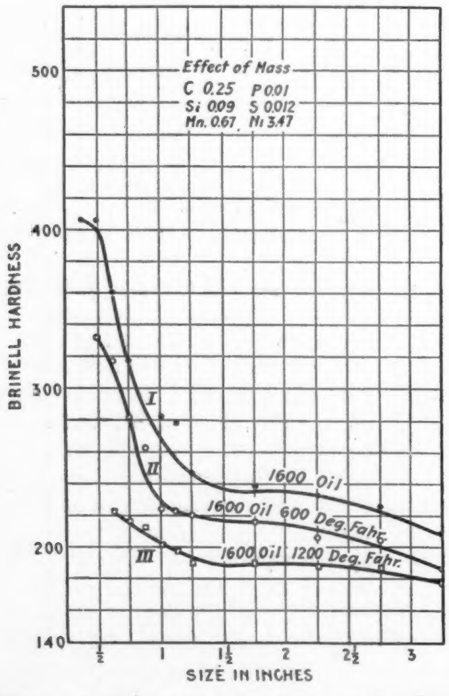



Fig. 13—Effect of Mass Upon Hardness; Nickel Steel Quenched in Oil

tures than at higher temperatures. A comparison of curves in Figs. 4 and 5 show the variation in quenching power of the same oil due to continued service. The difference in quenching rates may well account for different results from the same steel in different shops, or in the same shop due to change of oil used.

It has been known for some time that different masses of the same material on being quenched under like conditions gave varying physical properties, but it is only within recent years that the quantitative effect has been measured. The authors give below a few results, which, although obtained several years ago, are printed for the first time. Test pieces 4 in. long were made from the same ingot in sizes increasing ⅛ in. in both breadth and thickness. The smallest was ⅜ in. square and the largest 3¼ in. square. Three ingots of different type analyses

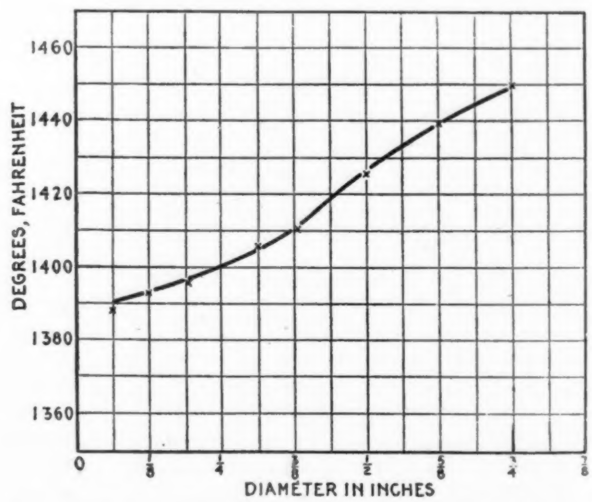



Fig. 14—Temperature-Size Curve for Hardening Tools

were chosen and a series of test pieces made from each. The test pieces were heated in a semi-muffle furnace to a constant temperature for each type of material, quenched, and the Brinell hardness test made. Each series was then drawn to 600 deg. F. in a salt bath and Brinell tests again taken and then reheated to 1,200 deg F. in a salt bath and Brinell hardness tests again run. The results are graphically shown in Figs. 10 to 13, in-

clusive, Brinell hardness being plotted against test piece size. It will be noted that the smaller the sample the greater the figure of hardness, indicating that the smaller sections are cooled with greater rapidity than the larger, and hence more hardness is developed. The same agencies are at work in tool steel; the larger the mass the smaller the depth of hardness when quenched under similar conditions. For steel of constant mass, the higher the temperature, the greater the rate of cooling.

In order to produce the same amount of hardness in a small and large section it is necessary to heat the larger section hotter than the smaller. The authors were recently confronted with the problem of finding out the correct temperature for hardening tools made from the same steel in sizes varying from 1/16 in. diameter to ¾ in. diameter. The temperature-size curve shown in Fig. 14 was finally adopted. In other words, a 3/16 in. round will harden at 1,395 deg. F., while a ¾ in. round bar should be treated to 1,450 deg. F.—a difference of 55 deg. F.

*Time and Degree of Drawing Temper.*—After the hardening operation has been safely performed, the next important step is that of drawing the temper. This operation is necessary for two important reasons: The relieving of abnormal strains set up due to the quick contraction or expansion, and the breaking down of the extremely hard and brittle structure of the quenched steel. Expensive tools such as broaches, dies, etc., actually burst and fly apart due to the fact that the strains set up in hardening are not relieved by drawing the temper soon enough.

Standard ½ in. round A. S. T. M. test pieces were quenched from constant temperature in the same medium, and the temper drawn in the same salt bath at constant temperature for five minutes, fifteen minutes, etc.

| Elastic limit | Maximum strength | Elongation | Reduction | Brinell | Remarks |
|---|---|---|---|---|---|
| 228,750 | 260,137 | 2.5 | ..... | 425 | 1550-oil-800 deg. F. 8 min. |
| 201,125 | 214,562 | 11.6 | 45.4 | 390 | 1550-oil-800 deg. F. 20 min. |
| 175,000 | 183,187 | 12 | 49.35 | 340 | 1550-oil-800 deg. F. 40 min. |

Each of the results in the table is the average of four closely agreeing checks, and they show that time at the drawing temperature has a marked effect. The greater the initial hardness of the piece, the more marked is the effect of drawing the temper. By referring to Figs. 10 to 13 inclusive the actual values in Brinell hardness are shown. The piece of 0.25 carbon nickel, ⅝ in. sq., quenched in oil, shows a Brinell of 360; drawn to 1,200 deg. F., a Brinell of 223. The per cent decrease in hardness is 61. The piece 3¼ in. sq., quenched shows a Brinell of 208; drawn to 1,200 deg. F., Brinell 183; only 13 per cent decrease.

The tendency of steel is to become spherical by repeated quenchings. Law, working with a square piece of tool steel 3½ in. by ½ in. by ½ in., quenched it 550 times and at the end of this work the piece was nearly round in cross-section. The ratio of length to diameter had changed from 3½:½ to less than 2:1.

Many years ago, one of the authors made several hundred hardening experiments and several thousand measurements to study the change of shape. The materials used were cylinders of steel and taps. Crucible steel alone was examined and the following variables were considered: The effect of original form or diameter upon the diameter after hardening; the influence of carbon on change of form; the influence of initial temperatures at quenching; the influence of length of time of heating; the influence of repeated hardenings, and the effect of annealing previously hardened steels, upon change of shape in rehardening. Obviously when plain cylinders of steel are considered, there are four changes of shape possible; expansion in length and diameter, contraction in length and diameter, expansion in length and contraction in diameter, and contraction in length with expansion in diameter.

Under the influence of the variable conditions mentioned above, all four changes were actually produced. Steel was also found which expanded in length on first hardening and contracted indefinitely thereafter on repeated hardenings. Another steel expanded in length on two hardenings, and contracted on the next two. In a variable carbon series of steels from 0.50 to 1.33 per cent carbon, the magnitude of the change in length after four hardenings, increased as the carbon increased. For the same series it was noted that the volume changes were greater when hardening annealed rather than unannealed bars. The increase in length is greater the higher the hardening heat for all carbons. The point we wish to emphasize strongly is that it is variable conditions that give variable results. It is only under varying conditions of heat, size, time, composition, etc., that the results vary. Above the decalescence point, the coefficient of dilatation increases proportionately with the carbon and for all carbon percentages the rate of dilatation increases with the temperature. Resulting changes of form are conditioned by the original proportions of the piece quenched, by its chemical composition, by the temperature from which it is quenched, and within certain limits by the time of heating. Hardness, brittleness, change of form and liability to crack, generally speaking, increase with the carbon content and the temperature and time of heating.

Constant conditions are not always attainable. The maker of steel cannot control conditions in his customer's shop and the customer cannot control conditions in the steel plant and the human element must be considered in both.

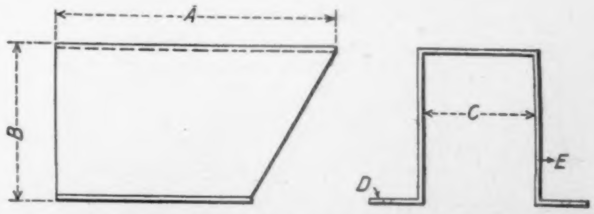
*Furnaces and Methods of Heating.*—Much has been said regarding the superiority of gas furnaces over oil furnaces and vice versa. The fuel used is immaterial for good practice so long as the following points are taken care of: The furnace and hearth should be of sufficient size so as not to be affected materially in temperature by the introduction of the parts to be hardened. The furnace should heat at a uniform rate. The furnace should be of uniform temperature over its entire hearth. The furnace should be run under neutral, or reducing, conditions. A good rough test for this is the introduction of a piece of wood or paper upon the hearth. If the paper or wood burns, the atmosphere is oxidizing; if it chars, reducing or neutral. The temperature control must be at all times exact, and it must be possible of exact duplication on repetition work.

A blacksmith's fire is satisfactory under good handling, but the difficulty is the fact that for constant work it is too exacting on the operator and requires too many manipulations to secure uniform and continuous results. To expect uniformly good and consistent results from a hardener whom you have not provided with adequate or suitable equipment is unreasonable. When the question of good equipment in the way of furnace, quenching arrangements and mediums, pyrometers, etc., has been satisfactorily taken care of, your hardener still has plenty of variables to contend with which are beyond his control.

## GUARD FOR VISE TAIL PIECE

BY W. B. MIDDLETON
Roundhouse Foreman, Atlantic Coast Line, Rocky Mount, N. C.

It is usually a difficult matter to keep employees from disfiguring the tail pieces of bench vises about the shop by using them as anvils for light riveting and small jobs of chipping




Guard for the Protection of Vise Tail Pieces

on odd shaped pieces. To protect the tail pieces from injuries received in this way, which often interfere with the proper operation of the vise, the simple guard here shown has proved

of considerable value. It is made of 3/16 in. scrap iron and is slipped over the tail piece of the vise, where it is secured to the bench with bolts or lag screws.

## DOES MODERN APPRENTICESHIP PAY?*

By L. L. PARK
Superintendent of Apprentices, American Locomotive Company

What is the advantage of apprentice training by shop instructors and by shop schools?

By comparing the work of apprentices with that of specialists and mechanics employed at random, it has been found that less work is spoiled by the apprentices than by the others. This is due in part to the greater thoughtfulness developed by the apprentice scheme, which has taught the young man to use his head as well as his hands.

Where the use of drawings is involved, the school-trained apprentice is less likely to misread them and he is apt to use better judgment in the following of directions. If taken soon enough after leaving school and followed up closely, the apprentice has less to "unlearn" and it is easier to teach him to be accurate and careful than is the case if he is picked up later and taught to specialize. He needs, however, more attention at the start than is likely to be given him when there is no special instructor.

Apprentices also are less severe on machines and develop greater care in the handling of tools. Of the total cost of machine maintenance from breakage due to carelessness, only a small percentage is chargeable to apprentices. They are more apt to have a bigger notion of the value of machines and do not take so many chances as do the others, although they soon learn to work the machines to their safe capacities.

By systematic instruction in the care and handling of machines and the mathematics relating to their operation, the apprentice has been found to be more resourceful in the handling of his work than is his fellow employee, and he can often "make good" on work where others have failed. Cases might be cited where specialists have repeatedly been unable to produce their rate on certain machines and jobs, while apprentices who have taken hold of the same work on the same machines have made an excellent showing. These results cannot be produced by a method which leaves too much to the initiative of the worker, but initiative plus training will accomplish them.

An apprentice scheme which permits apprentices to work on a piece-work basis during the larger part of their course will enable the future mechanic to adjust himself more readily to the piece-work system than do those who must start as piece-workers or who change suddenly from a day-work to a piece-work plan. Here the instructor plays an important part and shows the boy why he fails at first to make good and enables him to discover a better method rather than turning down the job as hopeless. The school also helps to develop originality and gives the boy greater self-reliance.

A still further advantage of modern apprenticeship is the flexibility with which vacant places in the shop may be filled. A man is out sick and an important job is standing. The instructor is here able to transfer to that machine an apprentice who has handled similar work, and, if he needs attention in getting started, it is the instructor who stands by and gives the needed help.

One of the most important advantages of the modern plan is the good feeling which is usually established between the employee and the employer. The instructor has been chosen because of his ability to deal wisely with boys, and he is able to straighten out many difficulties which ordinarily would cause friction, and the boy is often made to feel that he is getting a square deal where the busy foreman might have left half-adjusted matters which would have led to lasting ill-feeling. The attention given the apprentice during his term of service also helps to make him feel that his employer is interested in his welfare, and the system brings to the boy influences which give him a broader view of industry and its problems.

It is sometimes stated that too much attention makes apprentices feel that they are privileged characters, but it has been our experience that, with wise direction, there is less danger from this cause than from the spirit which usually accompanies too little attention.

The old system of leaving apprentices to the care and instruction of the foreman may be satisfactory in a small shop, but in a large department it usually means failure for the apprentice scheme. Many foremen have said that "apprentices are a nuisance" when this method is tried. Few foremen have time to give personal attention to the boys, and the actual instruction must fall upon some one else. We have yet to find a foreman whose attitude toward apprenticeship has not radically improved when an instructor has been placed over the apprentices. The common complaint of having "too many" has, not infrequently, changed to a request for "more."

Where apprentice instruction is left to "the man on the next machine," the things taught are far from uniform and often wrong in their principle. Only by a supervising instructor can this teaching be standardized and brought up to date. The present importance of "safety first" makes doubly necessary the training of the apprentice from the very start in the habits of caution and carefulness. This can be done without any sacrifice of output if the proper attention is given to the learner.

If the apprentice is to be developed to the highest extent he must have more than casual attention. Our agriculturists have long been studying how to make most productive the soil from which their produce must come, but the manufacturer has been very slow to realize that the human element of industry needs cultivation to bring about its highest productive ability.

Not only has the well-planned apprentice course given better training to the boys learning the trades, but it has attracted to the trades boys of higher intelligence. Many bright boys leave industrial shops because they see no opportunity for advancement, no provision for their getting proper instruction and change. While it is true that most men specialize after learning their trades, it is unquestionably true that their broader training has made them better mechanics in the special line which they have chosen.

While it is possible to make an apprentice school unnecessarily elaborate, a school which teaches the essentials of shop practice and the theories and mathematics underlying shop methods cannot but prove of benefit to an apprentice. It is more economical to teach a principle once to a class of twenty than to tell it twenty times to individuals in the shop. It has been found that the time spent in day classes is not a loss from the shop's viewpoint, but that, because of the greater interest and the change of work, the boys will accomplish as much on days when an hour is spent at school as they will when there is no school to attend.

As might be inferred from the foregoing, the shop supervisor and the instructor are the keys to modern apprenticeship. Some apparent failures of the system have been really failures of the supervisor or instructor, and the greatest of care is needed in the selection of these men (or man, if both positions are combined). Not every good mechanic can qualify as an apprentice instructor; he must have natural ability to teach and he must understand boy-nature, and be gifted with patience and tact as well as firmness. Too much emphasis cannot be placed upon this matter, for the investment will pay or lose, dependent upon the selection of the men who lead the work.

*From The National Association of Corporation Schools Bulletin.

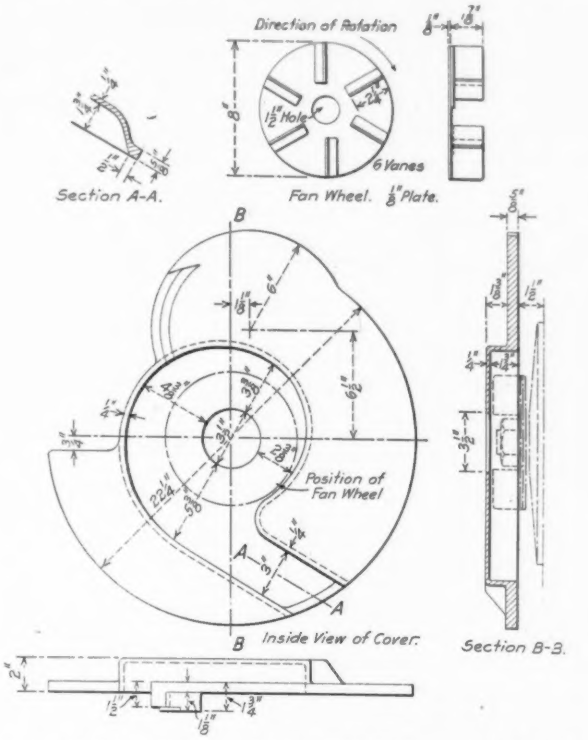
Steam Boiler Specifications.—It is reported that the steam boiler specifications furnished by the London Guarantee & Accident Company, Ltd., Chicago, will conform to the standard specifications of the American Society of Mechanical Engineers.

## GRINDING WHEEL PROTECTION

BY E. T. SPIDY
Assistant General Foreman, Canadian Pacific, Winnipeg, Man.

The grinding wheel guard shown in detail in the engravings was designed with two objects in view. The first was to provide an adequate means of protection for the wheel and the second to collect the fine particles of grinding dust that are thrown off into the air by all grinding wheels.

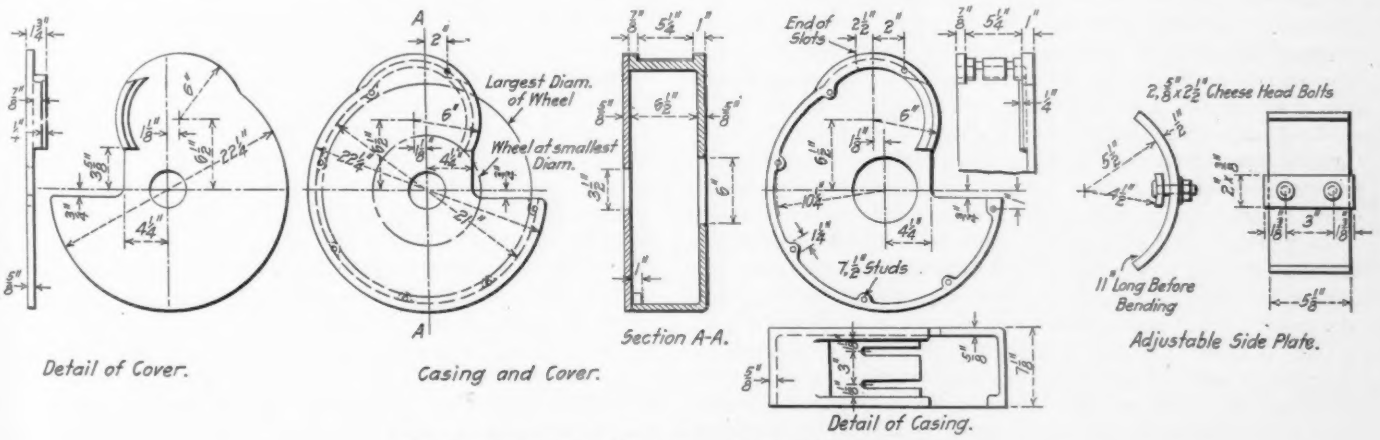
The guard consists of a box casing and a cover and is fitted




**Cover and Fan Used to Collect Dust from Emery Wheels**

with an adjustable slide which is let down as the wheel wears. The slide will accommodate wheels ranging in diameter from a maximum of 20 in. to a minimum of 10 in., which is large enough so that but one size of guard is required for all the general purpose wheels in a railway shop. The casing is made of cast iron and requires no machining beyond the drilling of bolt holes for fitting it together.

The arrangement for collecting dust consists of a small fan, the construction of which is shown in one of the engravings. This is attached to the outside collar of the grinding wheel and occupies a recess cast in the cover. A hole is cast in the casing so that a pipe may be attached and the dust conducted away from the wheel into a water box if desired. The draft induced by the small fan has proved to be sufficient to drive a large part of the dust out through the pipe, and it does not use enough additional power to require any change in the size of belt. On grinding wheels where the amount of dust is small or where it is not objectionable, the casing is provided with a plain cover and the fan is not used.




**Details of Grinding Wheel Guard, Showing Plain Cover**

## MEASURING EFFICIENCY*

BY H. L. GANTT

The widespread interest in the subject of management which has grown up within the last few years, has, I believe, a deeper significance than is at first realized. The readiness with which employers of labor have been willing to seek advice from almost anybody calling himself an "efficiency engineer" is hard to understand on any theory except that many employers realize that they are not operating their plants as well as they should be operated; and the fact that so many so-called "efficiency engineers" with but little experience or training have been able to accomplish results apparently well worth while, seems to bear out the theory that the art of management as practiced by many employers is still in a very crude state.

To be sure, many efficiency engineers have become discredited and gone out of business, but others have entered the field, and apparently the number in active practice is greater today than ever before. It would be impossible for such a large body of men to find employment unless at least a fair number of them were doing some good.

It is a fact that the agitation of the subjects of management and efficiency during the past few years has caused many employers to study their management problems very much more closely than heretofore, with the result that there has undoubtedly been a marked improvement in the efficiency with which industrial operations as a whole are being conducted. But in spite of this increase in efficiency, the greatest of our industrial problems, the relation between the employer and the employee, seems but little nearer solution. As a matter of fact one of the most efficiently run plants I have ever seen promises, unless my theories are all wrong, to widen the gap between employer and employee. The solution lies deeper, and before we can make any real progress toward it, we must revise some of our fundamental conceptions.

With the growth of competition within the last 20 years the necessity for some knowledge of costs became evident, and the manufacturer turned to the accountant for a system of finding costs. The present system of railroad accounting had been de-

*Abstract of a paper presented at the annual meeting of the American Society of Mechanical Engineers, held in New York, December 1-4, 1914.

veloped, and certain ratios accepted as measures of efficiency of operation; notable among them the ratio of operating expense to total income. The financier demanded a similar simple measure of the efficiency for an industrial plant. The cost accountant promptly gave him what he called the ratio of non-productive to productive labor, which he said should be low for good management. By non-productive labor he meant salaries of all kinds, and all other labor that could not be charged directly to an order, including miscellaneous labor such as watchmen, sweepers, truckmen, etc. By productive labor was meant simply that labor which could be charged directly to an order.

While the ratio of operating expense to total income may be a fair measure of efficiency in a transportation company, the ratio of non-productive to productive labor is not only not a fair measure of the efficiency of operation in a manufacturing plant, but is often exactly the reverse. The widespread use of this ratio as a measure of efficiency has been more effective in producing inefficiency than any other single factor except the oft-repeated statement that you must have low wages if you would have low costs. Until these two fallacies are absolutely discredited, we cannot expect a solution of our most serious problems.

Of these two fallacies, the second seems to be yielding gradually to the overwhelming mass of evidence against it. So many cases are now on record where the industrial engineer has increased output, raised wages, and at the same time lowered costs, that only those who are too conservative to investigate are still holding on to the old theory. With evidence of this kind at hand, it is safe to say that this fallacy will before long be entirely discredited. The other fallacy, that the ratio of non-productive to productive labor is a gage of efficiency, is so firmly rooted, however, that it is hardly to be expected that it will yield in the near future.

If any expense is really non-productive, contributing nothing to the end for which the factory was established, it should be eliminated. The salaries of the officers, foremen, janitors, truckmen, and laborers, as well as the money paid for taxes, insurance, or interest are necessary to the operation of the factory and therefore productive. I prefer to call all such expenses that have to be distributed indirect expenses, and those that are chargeable to specific orders direct expenses. The ratio referred to is thus more correctly described as that of indirect to direct labor, and to base any conclusions as to the efficiency with which a factory is run on it is misleading, often being productive of inefficiency rather than efficiency. I might give numerous examples to bring out this fact, including one where two men took the place of 16, and a daily direct wage of $8 took the place of $48, with but little increase of the corresponding indirect expense. The result was that the ratio for that shop became over double its former value with a marked reduction in the total cost. Needless to say, that the ratio theory in that plant is not regarded with the same reverence that it once was.

In plants where such results have been accomplished, those who have been accustomed to worshipping this ratio at once demand another idol in place of the one that has been so badly discredited. Inasmuch as the efficiency of the operation of a factory is made up of the efficiency of a great many independent operations, and is really indicated only by the cost of the various articles produced, there has not yet been found any easy way of indicating the efficiency without first getting the cost of the individual articles. Having been accustomed to an idol, however, both the accountant and the financier demand one, and are loath to give up the idol they have so long worshipped, no matter how badly shattered it may be. But when a reliable cost system has been installed, this idol becomes so badly discredited that even its most devoted high priests are obliged to abandon it.

In discussing cost systems, I wish to confine myself to the problem of how to get a true knowledge of the various items of labor and expense, both direct and indirect. This subject seems to have been given but scant consideration by the average accountant, who has usually assumed it to be easy and devoted his energies to working out elaborate theories as to what should be done with the various items of expense. Inasmuch as I find that the information which the office gets of what the shop has done is, as a rule, not very reliable, I feel that it is far more important to get this information correct than to get up elaborate schemes for using it. We shall therefore confine ourselves to the consideration of what the essential elements of a reliable cost system are, and how to get an exact knowledge of them. These elements are a knowledge each day of (a) what was done the day before; (b) who did it, and (c) what was paid for it. It is necessary to check these items daily, for it is impossible to check them accurately after the lapse of any appreciable time.

It is comparatively easy to get a set of returns purporting to give the above information, but the real difficulty comes in knowing whether these returns are correct or not. The only sure way of knowing whether these returns are correct or not is to know beforehand (a) what should be done the next day; (b) who should do it, and (c) what should be paid for it.

When we have arrived at a condition under which we can plan our work in advance on these lines, we have the basis of a real system of management, in which we can promptly check what has been done with what should have been done, and know with certainty each day how we stand.

It is not my intention to go into details as to how this can be done, as the subject is too big for a paper of this character. However, as the criticism will be at once raised that the clerical work needed would be so great as to make it out of the question, in reply I may say that even in the most poorly run business, some attempt, either consciously or unconsciously, is made to control work on these lines. Moreover, we generally find that the more nearly the above ideal is approached, the more successful the plant is, and all will admit the desirability of such a system if it can be established without excessive clerical work. As a matter of fact the clerical work needed to operate the best systems of this type is decidedly less than that needed to operate any of the standard cost systems put in by chartered accountants.

It must be borne in mind, however, that during the process of installing the new system and training the employees to operate under it, the old system must be continued; and not until each function performed by the old has been taken over by the new can we drop the old entirely. During the process of installation, therefore, we must to a large extent operate two systems. This necessarily runs up the ratio of non-productive to productive expenses, and the accountant lifts up his hands in horror at the expense of the new system. If at the same time the new system is successful in reducing the productive labor, the ratio is still higher, and the "showing" is still worse, even though the total cost is less. I therefore repeat that the first step to be taken before introducing a modern system of management is to eliminate the ratio of non-productive to productive labor as a measure of efficiency. The establishment of the fact that total cost is the only reliable guide will do much to pave the way for an improved system of management.

The first step in accomplishing this is to revise our ideas as to the functions of a cost system. In the past the principal function of a cost system, besides indicating a limiting selling price, has been to enable those in financial control to criticize those operating the factory. These criticisms are usually from one to three months late, and are so general in their character as to afford, as a rule, no guide whatever by which the superintendent can be governed. Such a system is too often most highly prized for its worst defect, namely, that it enables those in financial authority to criticize without taking any responsibility whatever for showing how to do better.

If, instead of making the function just described the prime one, we raise to equality with it, a function which requires the system to furnish promptly, day by day if necessary, exact in-

formation of what has been done and what the expenditure has been, we shall find that its most valuable function becomes, not finding costs, but furnishing the superintendent with information which helps him to reduce costs. In other words, before we can expect to get any great benefits from the newer managerial ideas, we must readjust our ideas of the functions of the cost accountant, who must become the servant of the operating executive as well as of the financial executive.

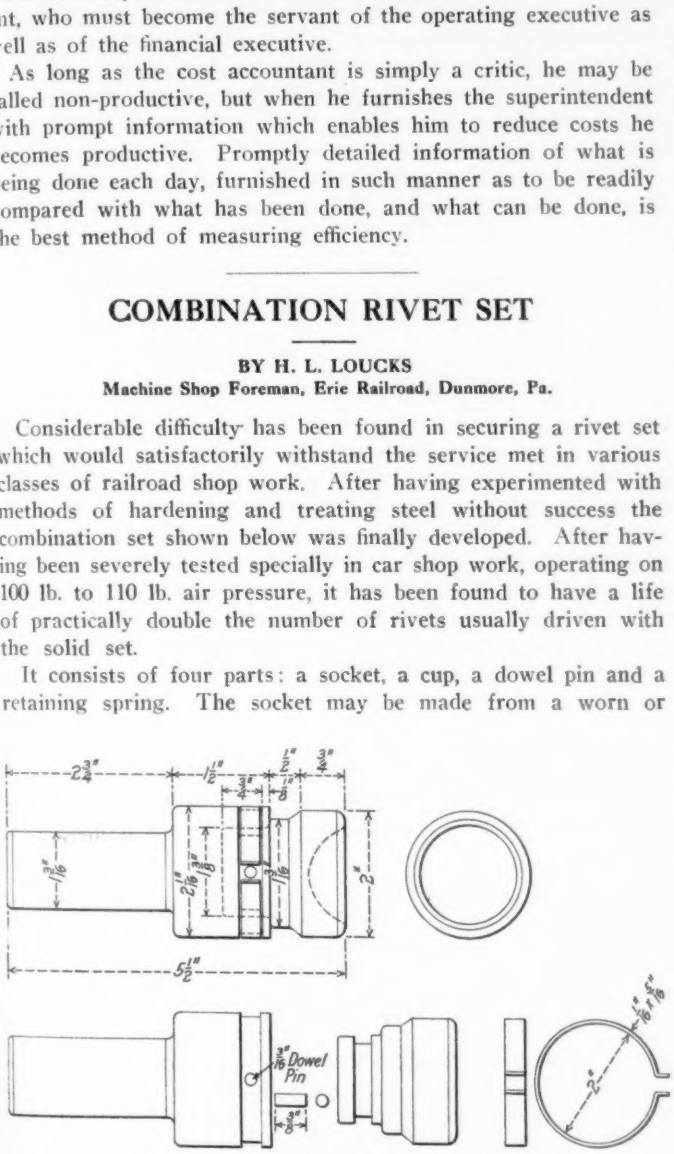
As long as the cost accountant is simply a critic, he may be called non-productive, but when he furnishes the superintendent with prompt information which enables him to reduce costs he becomes productive. Promptly detailed information of what is being done each day, furnished in such manner as to be readily compared with what has been done, and what can be done, is the best method of measuring efficiency.

## COMBINATION RIVET SET

BY H. L. LOUCKS
Machine Shop Foreman, Erie Railroad, Dunmore, Pa.

Considerable difficulty has been found in securing a rivet set which would satisfactorily withstand the service met in various classes of railroad shop work. After having experimented with methods of hardening and treating steel without success the combination set shown below was finally developed. After having been severely tested specially in car shop work, operating on 100 lb. to 110 lb. air pressure, it has been found to have a life of practically double the number of rivets usually driven with the solid set.

It consists of four parts: a socket, a cup, a dowel pin and a retaining spring. The socket may be made from a worn or




Built-Up Rivet Set

broken solid set, annealed and turned to the dimensions shown in the drawing. The cup is made from old locomotive tire steel forged and finished in a lathe.

The use of a separate cup and socket results in a distribution of the stresses which overcomes the tendency of the solid sets to break at the shoulder between the stem and the head. The socket lasts indefinitely and new cups may be provided as required at a cost not exceeding one-half of that for new solid sets, the steel for which is expensive.

FORMIDABLE LOOKING FORMULAS.—Many engineers will go down without a struggle before a formula which has a logarithm, entropy or a sine, cosine or tangent in it. It is just as simple to look up one of these quantities and to substitute the value given in the table for the letters of the formula as it is to hunt up the steam temperature corresponding to a given pressure, or the area corresponding to a given diameter, and the same book which contains the tables of the properties of steam and of circumferences and areas will usually have the other things, too.—*Power.*

## BOILER WASHING AND FILLING SYSTEM FOR SMALL ROUNDHOUSES

BY WILLIAM WELLS

The fact has been fairly well established that the use of hot instead of cold water for washing out locomotive boilers will produce better results, as regards the effect on the boiler structure, the amount of sediment and scale removed, and the time consumed in the washing operation. The filling of locomotive boilers with clean hot water also has allowed the movement of a locomotive out of the roundhouse within 30 minutes after the filling operation was completed, a marked reduction in the time required for obtaining the necessary amount of steam for moving the engine when cold water was used, and one which has an important bearing on the prompt handling of locomotives at terminals. While the results obtained have been in the main satisfactory, and the expense of the well designed boiler washing and filling systems on the market generally has been justified for the larger terminals, the first cost of these systems has prevented railway officers from authorizing their installation in the small roundhouses, located at points where the number of locomotives handled daily and the importance of the traffic would not seem to justify this expense.

Most small roundhouses require the installation of a steam boiler equipment for the drafting of locomotives, operating water pumps, air compressors and a stationary engine, the exhaust steam from which contains sufficient heat, if properly utilized to provide an adequate supply of hot water for boiler washing and filling purposes where the requirements of the engines handled are not in excess of the heat contained in the steam available. As exhaust steam at one pound pressure has a total heat content of 1,152 B. t. u. per pound in comparison with a heat value of 1,192 B. t. u. for steam at 125 lb. pressure, it will be seen that exhaust steam which usually is passed to the atmosphere through the exhaust and is therefore wasted, contains within 3 per cent of the heat which is contained in steam at the higher pressure.

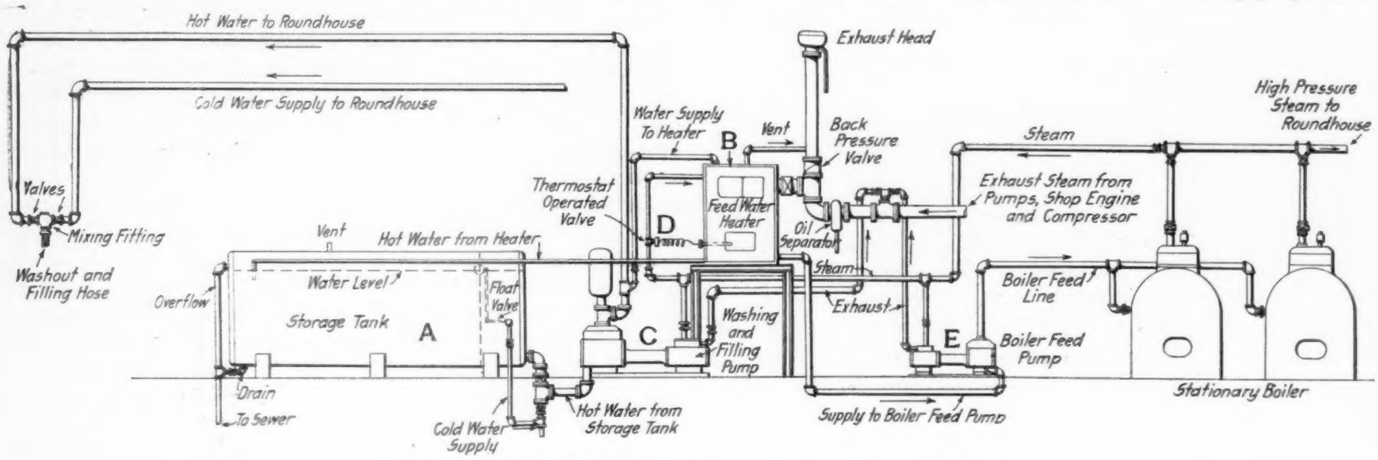
The accompanying drawing shows a design for a boiler washing and filling system which uses exhaust steam for heating the water and from which may be obtained results which approach those possible with the larger systems to a closer degree than may be obtained by any form of sump. The system has been designed with the idea of getting the greatest results with the least expenditure of money for plant equipment, and the only apparatus necessary over that required for a roundhouse with a washout pump is the feed water heater, the storage tank and the necessary piping, valves and fittings for the hot water line. The feed water heater may be of simple design, possible of manufacture without difficulty in any railroad boiler shop; the storage tank may consist of one or more condemned horizontal tubular boilers with the tubes removed, and properly fitted up to contain water.

In the drawing, *A* is the storage tank containing a supply of hot water for boiler washing and filling purposes, *B* is a small feed water heater, of the open type, made of either cast iron or steel, for heating the water, *C* is a steam pump of the ordinary reciprocating type for supplying the hot water under pressure and circulating the water in the storage tank through the heater when the locomotive boilers are not being washed out or filled. Instead of using the pump *C* for circulating the water a separate pump of smaller capacity may be used with equally good results and possibly no increase in the amount of steam required for circulation. The thermostat-operated valve *D* may be installed or omitted as desired, its function being to admit live steam to the heater when the temperature of the water entering the heater falls below a certain predetermined point due either to a deficiency of exhaust steam or excessive use of water from the system. The boiler feed pump *E* is of the reciprocating type and may be dispensed with if the stationary

boiler pressure is equal to or less than that used for washing and filling locomotive boilers.

In the operation of the system, water is maintained at a constant level in the storage tank *A* through the action of a float operated valve in the cold water supply connection. Exhaust steam is admitted to the feed water heater, after having all oil removed by a separator provided for the purpose, and comes in contact with and heats the water from the storage tank entering the heater through the water supply connection which in the drawing is a by-pass from the discharge line of the boiler washing and filling pump. By a continuation of the above process the water in the storage tank increases in temperature until the boiling point is reached, or until the water is used for either washing or filling the boiler through the pump.

In a small roundhouse the number of locomotive boilers requiring washing out and refilling usually does not exceed three in a period of 24 hr., and with an allowance of 50 min. per engine for the washing operation and 20 min. for filling, there remain practically 20.5 hr. out of every day for building up the temperature of the water in the storage tank. Dividing the time the system is not delivering water for washing and filling by the number of engines handled, an average of about 6 hr. per locomotive handled for heating the water in the storage tank, is obtained. Results from service tests on two modern boiler washing and filling systems installed in large roundhouses show that an average of 4,800 gal. of washing water and 2,600 gal. of water for filling were required per engine handled, the number of locomotives having their boilers washed out and refilled during the 24-hour period of the tests being 14 in one case and 10 in the other.




**Hot Water Washing and Filling System for Small Roundhouses**

On account of difficulty experienced with the use of water at a temperature over 120 deg. for washing out purposes, cold water must be admitted in the pump discharge line to obtain the desired temperature. Assuming that 4,800 gal. of water is required per engine washed out and a temperature of 180 deg. in the storage tank—a figure which may be easily obtained by separating the washing and filling operations on different engines as much as possible—it will be necessary to admit about 2,400 gal. of cold water at 60 deg. to the pump discharge to obtain the 120 deg. working temperature.

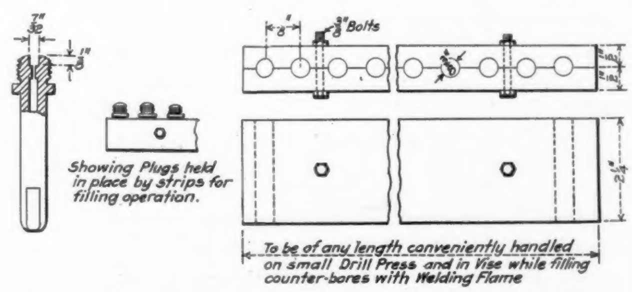
Using the above data as a basis, the capacity of a storage tank for washing out and filling three boilers per day of 24 hr. should be approximately 6,000 gal., or the water contained in one tank 16 ft. long by 96 in. diameter, or two tanks 16 ft. long by 72 in. diameter. A storage tank of this capacity would provide sufficient water for the washing out and filling of one boiler, and at the end of both operations the temperature would be approximately 80 deg., based on the admission of cold water equal in quantity to that used. As an alternative proceeding, by shutting off the cold water supply to the storage tank while washing and filling, 180 deg. water would be available during the operations and about 1,000 gal. would remain for subsequent use or a sufficient quantity to increase the temperature of the water required to fill the tank from 60 deg. to 80 deg.

Calculation shows that the amount of exhaust steam at one pound pressure required to raise the temperature of the refilled tank to 180 deg. would be approximately 5,550 lb., and the time required about 6 hr. Based on a uniform use of the steam for heating the water, approximately 900 lb. per hour would be used, or the amount obtained from an ordinary 25 hp. slide valve engine operating continuously at full load. The supply of feed water for the stationary boilers should be taken from the feed water heater direct as the temperature of the water in the heater will be uniform and always higher than that in the storage tank. In this connection it should always be remembered that the amount of coal required for steam making purposes is reduced approximately 1 per cent for each 10 deg. increase in the feed water temperature, a point not to be lost sight of in the operation of any type of boiler feed water or washing and filling system.

# RECLAIMING WORN LUBRICATOR CHOKE PLUGS

BY F. W. BENTLEY, JR.

Some time ago the air brake department was confronted with a shortage of new lubricator choke plugs for the bull's eye type of lubricator. A considerable number of these plugs, removed because of an enlarged condition of the restricted passage in the end, had been retained. In order to reclaim them a wood holder




**Holder Used in Reclaiming Worn Lubricator Choke Plugs**

was made in which 15 or 20 plugs could be secured at one time. The chokes were then countersunk with a 7/32-in. drill, care being taken that the drill did not penetrate the restricted portions of the oil passages. These apertures were then filled with brass by the use of the acetylene welding flame, the work being performed much like a soldering operation. The holder was then taken to a small drilling machine and 1/32-in. holes drilled through the solid ends of the plugs. This is economical even where but a small number of plugs are to be reclaimed.

# NEW DEVICES

## POWER PLANT OIL FILTER

The oil filter shown in Fig. 1 was developed in order to secure a filtering medium of increased efficiency and an arrangement of the plant which would make possible large filtering

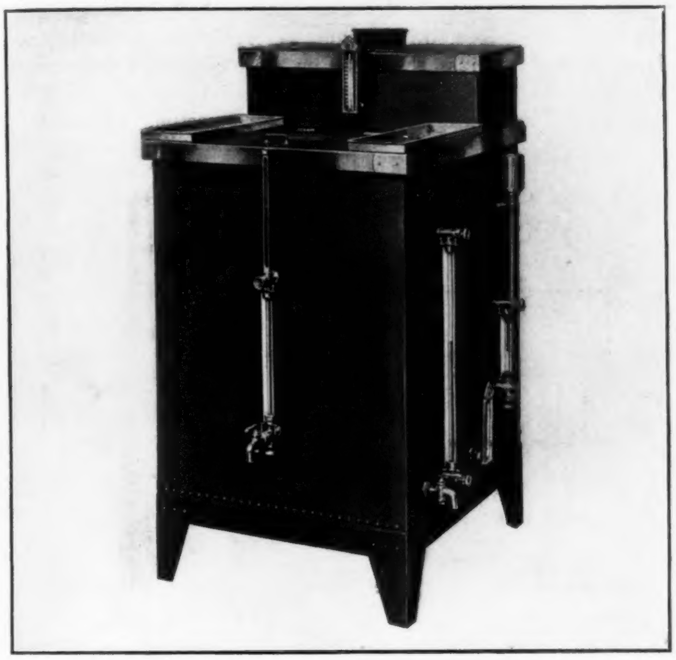


Fig. 1—Oil Filter Having Capacity of 100 Gal. to 200 Gal. Per Hour

capacity in a small space. The device, which is known as the Peterson power plant oil filter, consists essentially of two parts placed in the same case. The first is the precipitation com-

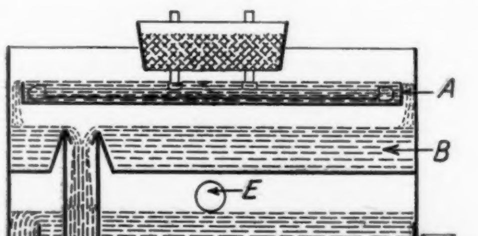



Fig. 2—Method of Operation of the Precipitation Compartment

partment in which water and the coarser particles of solid matter are removed; the second is the filter proper. Surrounding these two compartments is the storage space for filtered oil.

The dirty oil enters the filter through a strainer box, passing down through a removable strainer which catches large pieces of foreign matter, such as waste. A heater tray *A*, is located directly below the strainer, where the viscosity of the oil is reduced before it overflows into the compartment *B*. From this compartment the oil flows through a funnel and vertical conductor shown in Fig. 2. As it emerges from the vertical conductor the oil is spread out below the tray *C* by means of a baffle, and under the action of the head which accumulates in the vertical conductor the oil is forced to take a zigzag upward path, passing under and over several trays in its course. The level of the oil in the top tray is maintained constant by a skimmer shown at *D* in Fig. 3, the overflow from which passes to the filter compartment through the opening *E*.

As the oil flows over the trays the water separates and collects in the bottom of the trays, from which it is by-passed di-

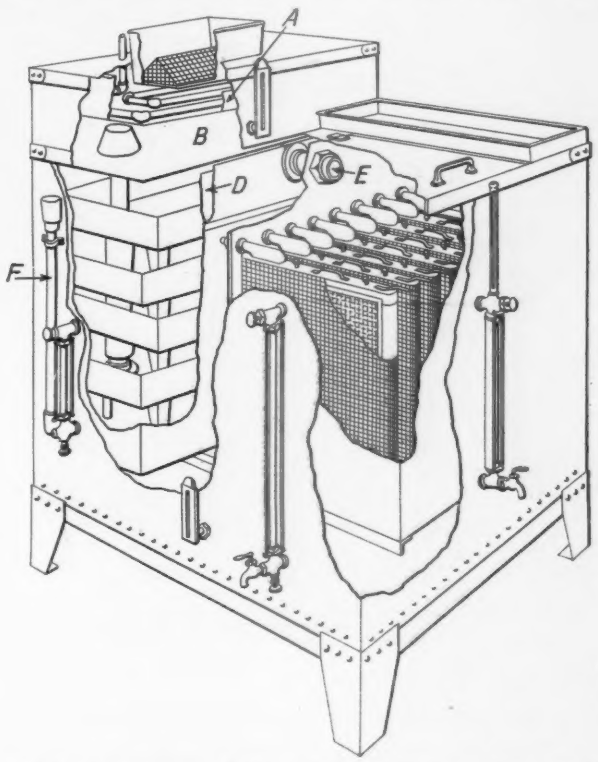



Fig. 3—Arrangement of the Parts of the Peterson Oil Filter

rectly to the bottom of the precipitation compartment by means of funnels surrounding the vertical oil conductor. These prevent the water from coming in contact with the moving oil after having once been separated. The water is automatically removed from the precipitation compartment by means of an overflow tube *F*. This consists of two concentric pipes, the outer one of which is connected at the bottom to the water chamber while the inner one leads to the drain. A funnel is threaded to the upper end of the inner pipe by means of which adjustment may be made to provide for oils of different specific gravities. The overflow operates on the U-tube principle; the column of water in the outer pipe balances the column in the filter, composed partly of oil and partly of water. The oil being lighter than the water, the top of the overflow is slightly lower than the level of the oil in the precipitation compartment. As more water collects in the bottom of this compartment the relative weight of the two columns is changed, that within the precipitation compartment becoming heavier, and the level in the over-

flow tube is raised until water flows over the top of the funnel into the drain. A low water level is thus automatically maintained in the precipitation compartment.

The filtering compartment contains nine non-collapsible filtering units, one of which is shown in Fig. 4. The oil passes from the outside to the inside of the filtering unit and then out through nozzles projecting through the wall of the compartment into the clean oil compartment. The nozzles fit into spring-actuated valves so that any unit may be withdrawn and cleaned without interfering with the continuous operation of the filter. When the unit is withdrawn this valve instantly closes and prevents unfiltered oil from flowing into the clean oil compartment. The filtering cloths are so arranged that they are free from folds or plaits, thus rendering effective their entire surface. They are placed in a vertical position, so that the slime and sediment collecting on the filtering surfaces continually works towards the bottom. The filtering units are thus largely self-cleaning.

No oil can pass to the clean oil compartment until the level in the filtering compartment reaches the outlets from the filtering

Fig. 4—Vertical Filtering Unit Removed from the Filter

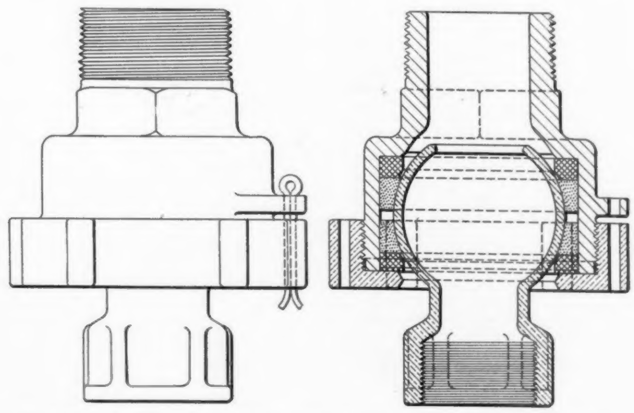
units; as soon as a slight head builds up over the outlets the process of filtration commences and is distributed over the entire filtering surface, all of which is subjected to equal pressure. The head of oil over the filtering unit is shown by the indicator at the top of the gage on the front of the filter. When operating at normal rating this indicator should show a level of about three inches of oil. Space is provided, however, for carrying oil to a height of six inches, thus making possible the handling for short periods of a 100 per cent overload.

Other gages are provided to show the level of the oil in the storage compartment and the water level in the precipitation compartment. A thermometer shows the temperature of the oil in compartment *B*, thus enabling the proper regulation of the heater coil. Another thermometer shows the temperature of the oil in the clean oil storage compartment, and when necessary the oil is passed over cooling coils before it is returned to the lubrication system.

The filter body is constructed of No. 12 gage galvanized sheet steel reinforced with channels and angles. All joints are lapped and closely riveted and soldered. The only parts needing periodical attention are the filtering cloths, and these are readily cleaned by removing the filtering units, without interfering with the continuous operation of the filter. The filter here illustrated has a capacity of 100 gal. to 200 gal. per hour, this being the basic unit by the duplication of which plants of larger size are built up. These filters were recently placed upon the market by the Richardson-Phenix Co., Milwaukee, Wis.

## MAIN RESERVOIR BALL JOINT CONNECTION

The accompanying illustrations show a ball joint developed especially for locomotive main reservoir pipe connections. Many engine failures are caused by the breaking of main reservoir pipe connections, due to vibration of the pipes, the effect of which is concentrated at the rigid connection in the reser-



Details of Ball Joint Pipe Connection for Main Reservoirs

voir. The body of the ball joint is threaded and screwed directly into the reservoir and the end of the pipe is screwed into the ball member, thus relieving the threaded connections of vibration stresses.

The construction of the joint is shown in the engraving. The

Main Reservoir Ball Joint Pipe Connection

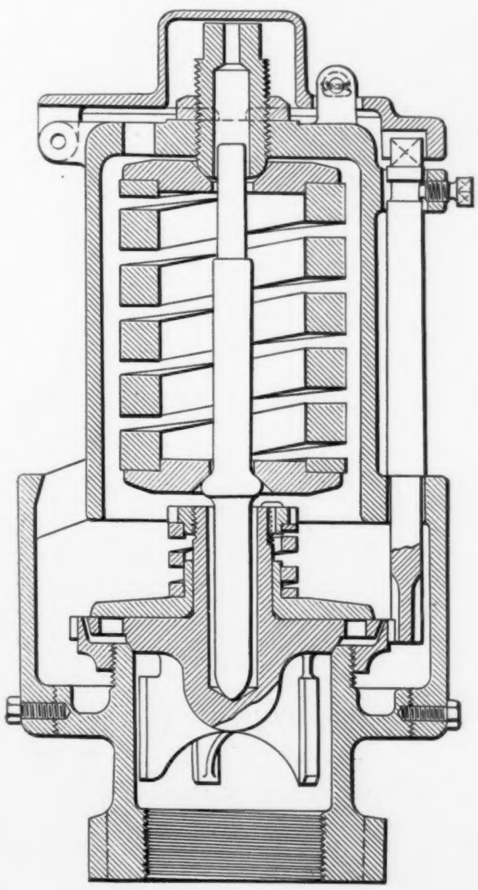
body is made in the form of a cylindrical casing in which are placed two rubber packing rings and two hard babbitt retaining rings. The packing rings form the joint with the spherical

surface of the ball member and are held in position by a gland nut on the casing.

This joint was developed by the Franklin Railway Supply Company, 30 Church street, New York.

## LOCOMOTIVE SAFETY VALVE

The accompanying illustration shows a new type of safety valve recently placed on the market by the Crane Company, Chicago. These valves are different from those heretofore made by this company, in that they have a greater lift and the casing is made of malleable iron. The main spring is also made of larger wire and the coil is of larger diameter. The lift has been increased on the open pop valve to 0.15 in., and on the muffler to 0.14 in., an increase of from .07 to .05 in. Excessive hammering of the valve as it closes from this relatively high lift is eliminated by the use of an auxiliary valve, also controlled by a spring, which covers a series of holes in the main valve, as shown in the drawing. As the main valve is lifted from its lower seat by the steam pressure, full opening is provided to it and the valve is lifted to its open position. As the pressure drops and the main valve lowers, steam will be caught in the cavities under the auxiliary valve, thus cushioning the main valve and preventing the severe shock that has many times been found very objectionable on high lift valves.



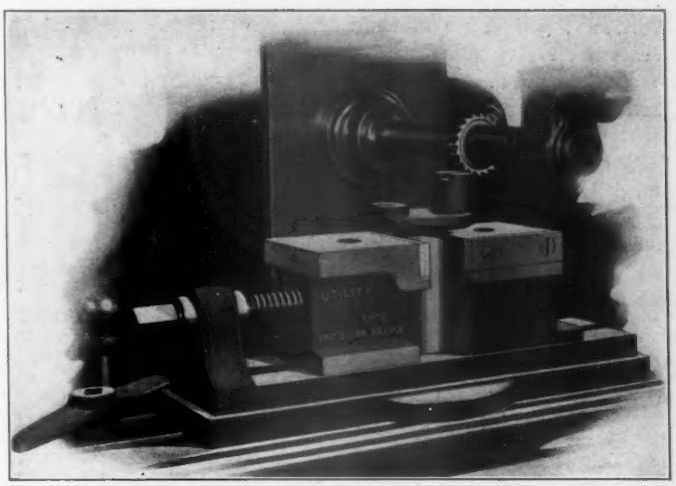
**Improved Crane Safety Valve**

The muffled valve is similar in construction to the open valve, and instead of using two muffler plates, as was done in the old type, only one is used, it being made a part of the casing. By means of these high lift valves it has been found possible to use smaller valves as the capacity has been so materially increased. The accompanying table shows the discharge of steam per hour with 2½ and 3 in. valves of both types.

| Type | Size | Boiler pressure | Lift | Discharge of steam per hour |
|---|---|---|---|---|
| Open ........ | 2½ in. | 180 lb. | .15 in. | 7,500 lb. |
| Open ........ | 3 in. | 180 lb. | .15 in. | 9,200 lb. |
| Open ........ | 2½ in. | 200 lb. | .15 in. | 8,300 lb. |
| Open ........ | 3 in. | 200 lb. | .15 in. | 10,100 lb. |
| Muffler ....... | 2½ in. | 180 lb. | .14 in. | 6,500 lb. |
| Muffler ....... | 3 in. | 180 lb. | .14 in. | 8,600 lb. |
| Muffler ....... | 2½ in. | 200 lb. | .14 in. | 7,200 lb. |
| Muffler ....... | 3 in. | 200 lb. | .14 in. | 9,400 lb. |

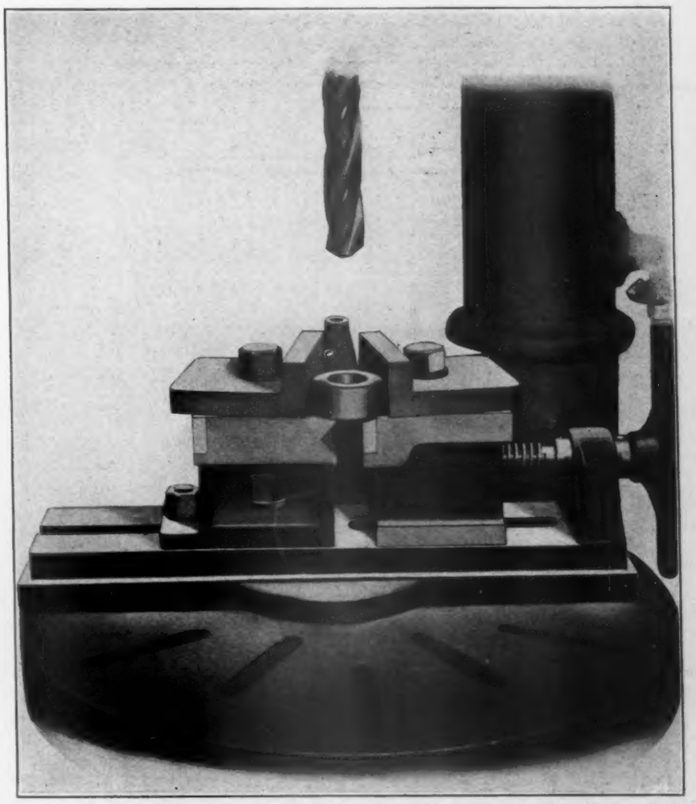
## GENERAL UTILITY VISE FOR DRILL PRESSES

The vise shown in the illustrations was designed to replace a variety of jigs and special fixtures for holding various sizes and shapes of work on the table of the drill press. It has proved to be equally adapted to other machines on which the work is held stationary, such as milling machines and shapers.



**Work Secured in Vertical V-Groove of the Utility Vise**

The vise consists of a flanged bed plate so designed that it



**Supplementary Jaws for Holding Irregularly Shaped Piece**

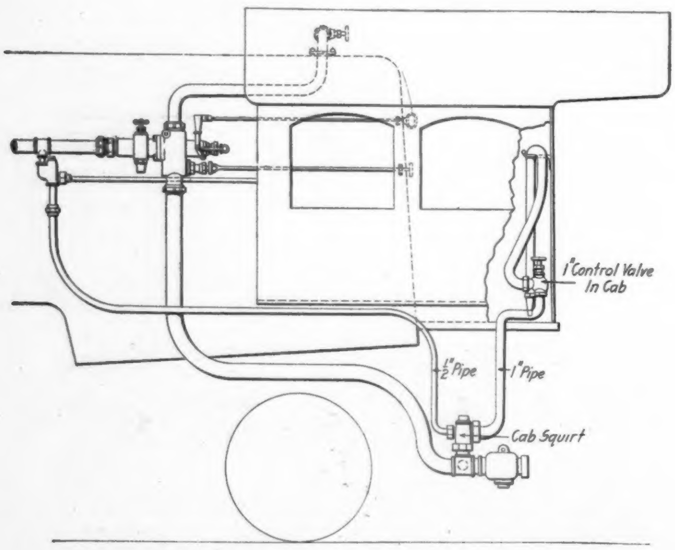
may be fastened to the machine table in any position, a screw operated front jaw, a stationary rear jaw and a variety of supplementary jaws which may be secured to the top of the main jaws for handling irregularly shaped pieces. The front jaw is held in position by a tongue passing through a slot in the bed and secured on the bottom with a plate and screws. The gripping surface is fitted with a removable steel plate. The rear jaw is made in the form of a hollow cube, one side being left open to admit a wrench for operating the nut on the binding bolt. The hole through which this bolt passes is drilled in the center of the jaw. It may thus be revolved on the bolt and fastened to the bed with any one of the three closed faces opposite the face of the front jaw. One of these faces is provided with a removable steel plate similar to that on the front jaw. Another is machined full depth for use as an angle plate, a vertical V-groove extending the full depth of this face to permit centering and holding rounds, squares and similar stock in a vertical position. The opposite side is provided with a horizontal V-groove for holding bar stock when drilling at a right angle to the a.:is of the bar.

One of the illustrations shows the adaptability of the device for holding irregularly shaped pieces by the addition of supplementary jaws to the top faces of the main jaws. These vises are manufactured by the Brown Engineering Company, Reading, Pa., and are provided with several types of supplementary jaws other than those shown.

## SQUIRT HOSE EJECTOR

The accompanying engraving shows the general arrangement and details of an ejector designed to furnish moderately warm water under sufficient pressure for the safe operation of the locomotive cab squirt hose. It was recently developed by the Ohio Injector Company, Chicago, Ill., and consists of two parts: the ejector, which is connected to the injector suction pipe near the strainer, and a heater check connected to the injector branch pipe. The operation of the squirt hose is controlled by a one inch valve in the cab.

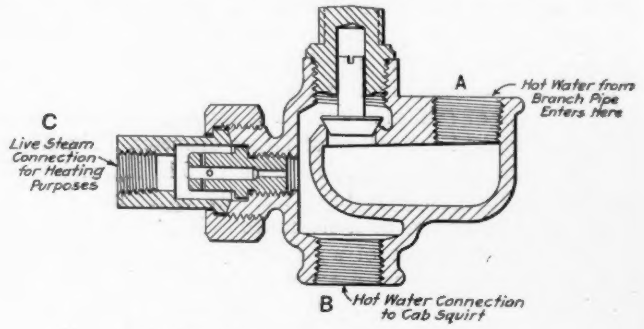
By referring to the sectional view of the heater check it will




**Arrangement of the Squirt Hose Ejector on the Locomotive**

be seen that when the boiler feeding injector is working, water at a high temperature and pressure enters the heater check at the opening *A*, which is connected to the branch pipe, lifts the check valve and passes out through the opening *B* into a pipe leading to the cab squirt. To prevent freezing in cold weather when the injector is shut off a small amount of live steam enters the heater check body through a choke fitting and passes through the opening *B* to the ejector. This steam is prevented from passing into the branch pipe by the heater check valve and an ordinary check valve placed at any convenient point in the live steam pipe prevents any tendency for water from the branch pipe to pass through the choke into the boiler when the injector is working.

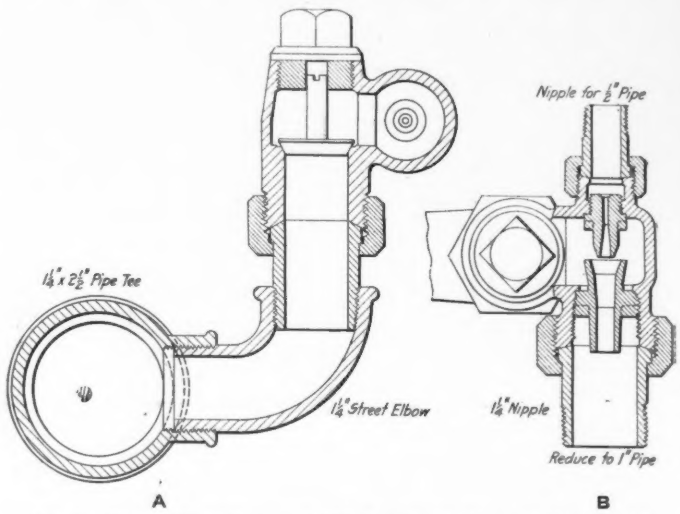
The water at high temperature and pressure enters the ejector




**Sectional View of the Heater Check**

through a one-half inch pipe, and whenever the control valve in the cab is opened it passes through the ejector combining tube, where it mingles with a large quantity of cold water drawn from the injector suction pipe through the check valve shown. The device is claimed to effect the delivery of a good stream of water at a moderate temperature and safe pressure.

In using this device the engineman is not required to make any movements other than those necessary with the usual form




A B

**(A) Sectional Elevation and (B) Sectional Plan of the Ejector Proper**

of cab squirt receiving its water supply directly from the injector branch pipe. All that is necessary is to have the injector working and to open the control valve. The device is applicable to locomotives fitted with injectors of either the lifting or nonlifting type.

BRITISH HOSPITAL TRAIN FOR THE CONTINENT.—At the Stratford works of the Great Eastern an ambulance train consisting of five ward cars, two kitchen cars, and one pharmacy car, has been built for service with the British troops in France, and presented by the United Kingdom Flour Millers' Association. The train is 428 ft. long. Each coach for the wounded will accommodate thirty men, thus giving room for 150 in all. The train is lighted by electricity, and the cookers in the two kitchen coaches are heated by anthracite fuel. At the top of the coaches are tanks of 300 gallons capacity for the water supply; the heating is by steam pipes, and each coach weighs between 27 and 28 tons.

## UNDERFRAME SUSPENSION OF CAR LIGHTING GENERATORS

An electric car lighting equipment has recently been brought out in which the generator is suspended from the underframe of the car instead of from the truck. The equipment is manufactured by the Safety Car Heating & Lighting Co., 2 Rector street, New York, and a number of sets now in service are claimed to be giving entire satisfaction.

Several conditions have arisen in connection with the suspension of car lighting generators from truck frames which are increasing the difficulty of properly designing this type of equipment for application to steel trucks and steel car bodies of the type of construction now commonly employed. The deep center sill generally used on all-steel and steel underframe equipment has limited the space available for applying the generator to such an extent that it is difficult to obtain the proper clearances for the generator and the driving belt. The suspension of the generator from the truck frame also produces an unbalanced condition in the loading of the equalizer coil springs, and the suspension is so low that snow and ice cause trouble during the winter months. The underframe suspension was developed to overcome these and other difficulties arising from the older method of suspension.


Fig. 1—Car Lighting Generator Suspended from the Underframe

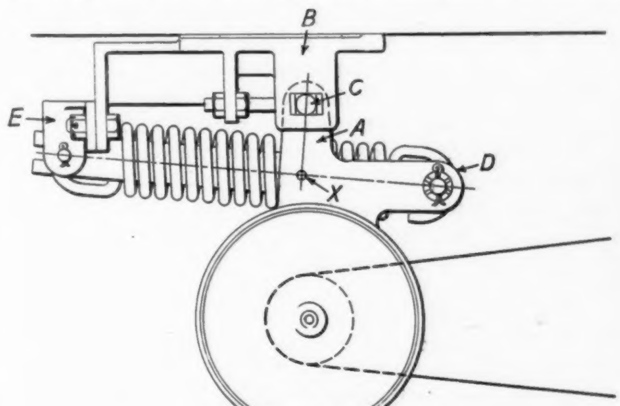


Fig. 2—Position of the Generator when Effect of Spring is a Maximum

The general appearance of the generator and its suspension and the method of attaching it to the underframe are shown in Fig. 1. The successful operation of this type of suspension depends upon the ability to maintain a uniform belt tension through the comparatively wide range of adjustment necessary to take care of the curving of the truck. The method of securing uniform belt tension will be understood by referring to Figs. 2 and 3. Cast on the generator frame are two carrying lugs *A*, which are pivoted to supporting lugs *B* on the suspension casting by a bar, the end of which is shown at *C*. The end of the tension spring shown at *H*, Fig. 4, is secured to a bracket *E* on the suspension casting, while the end shown, *G*, Fig. 4, engages with the lug *D* on the generator frame. The tension of the belt is the result of two varying factors, one of which is the horizontal component of the weight of the generator, and the other the tension of the spring. When the generator is hanging as shown in Fig. 2 so that its center of gravity is directly under the supporting bar *C*, the weight of the generator has no effect on the tension of the belt, but the tension of the spring has its greatest effect, since the lever arm, *CX*, is greatest. When the generator is swung into the position shown in Fig. 3, the effect of its weight is a maximum, while the effect of the spring is decreased due to the shortening of the distance *CX*. The parts are so designed that the combined effect of these two factors is practically constant in all positions. Ample latitude is provided between the two extreme positions shown to take care of belt stretch and the varying location of the axle due to the curving of the truck. The spring is assembled on a carrier under tension so that it may be easily applied and removed.

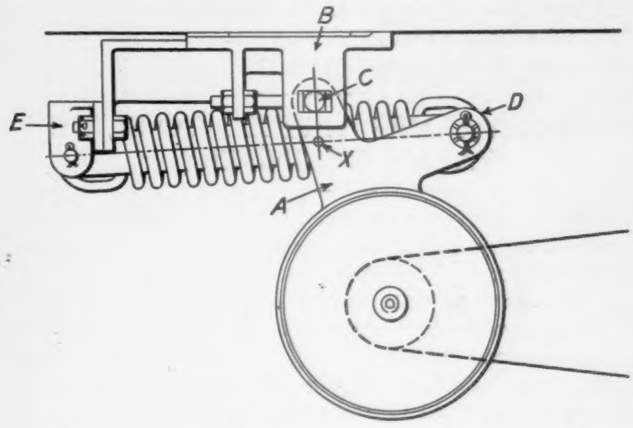


Fig. 3—Position of Generator when Effect of Weight Is a Maximum

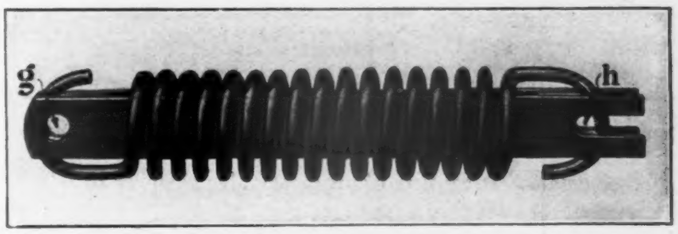


Fig. 4—Belt Tension Spring Assembled on Its Carrier

A simple means of lining the generator with the car axle is provided. The hole for the supporting bar in the lug *B* is slotted, the position of the bar in the slot being readily adjusted and locked by means of the bolt and lock nuts shown in the engravings.

With the increased belt clearances obtained with this equip-

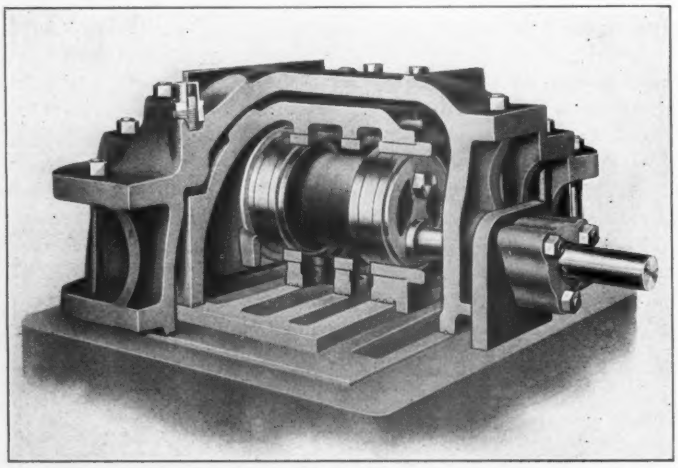
ment it has been possible to use a type of belt fastener which operates properly on small pulleys. A smaller armature pulley has therefore been used and a higher ratio between the axle pulley and the armature pulley obtained. The increase speed of the generator thus produced has made possible the design of a generator of lighter weight. This saving, together with the reduction in the weight of the suspension itself has resulted in a total reduction for this type of equipment of nearly 900 lb., and the truck has been entirely relieved of the unsprung and unbalanced weight usually suspended from one end of its frame.

The underframe suspension has made possible a considerable increase in the clearance between the generator and the track, and the moving parts of the suspension are still further removed from the track by being placed above the generator. The effect of snow and ice in severe weather conditions is therefore considerably reduced. The suspension of the generator from the car body also produces more favorable conditions with regard to wear since the moving parts, both of the generator and the suspension, receive the full benefit of the truck springs.

## PISTON VALVES APPLIED TO SLIDE VALVE CYLINDERS

The application of superheaters to existing engines having slide valve cylinders has heretofore presented serious difficulties in view of the accepted fact that only piston valves can be used successfully with superheated steam. The cost of new piston valve cylinders with their accessories, together with the new front frame sections necessary to obtain a good design of cylinders; the changes necessary in the valve gear, etc., frequently entail so considerable an expenditure as to cause abandonment of the project.

The device here illustrated offers a solution of the problem by enabling a piston valve to be applied to the existing slide valve cylinders without any modification of the cylinders, valve gear



Construction and Method of Application of Universal Piston Valve

or other details. It consists of an inner valve chamber to which a continuous bushing is applied in the ordinary manner. Enclosing this is a steam chest secured to the cylinder by the usual studs without alteration in their original arrangement. The valve chamber is secured to the valve seat by four studs, and six holding-down screws tapped through bosses on the top of the steam chest, in addition to the steam pressure, which is exerted over practically 70 per cent of the area of the seat.

Joint wires of the usual form are used between the steam chest and its seat and wires of the same size are employed between the valve chamber and valve seat. These latter wires are arranged in an ingenious manner to avoid the use of double wires on the bridges, where it is difficult to apply sufficient direct pressure to bed them into the irregularities of the faces. In this arrangement a joint wire surrounds each of the steam ports, and an outer wire surrounds the whole. Thus the double wires come only at the ends and sides of the valve seat where direct pressure can be applied.

A very short and light piston valve is used, with the center of its stem offset downward to conform to the location of the valve yoke stem of the original slide valve. The body of the valve is of oval section, thereby facilitating the passage of the exhaust steam downward to the exhaust port. The form of steam port in the valve chamber is such as to provide ample area for the ingress and egress of steam to the ports in the bushing, and eliminate all baffles which cause eddy currents.

The valve diameter is determined by the length of the ports in the valve seat, being such that its effective length (deducting bridges) is somewhat greater than the port length of the flat valve seat, which has been proved by actual test to be sufficient. This method gives valve sizes and weights as follows:

| Port length | Valve diameter | Weight of valve |
|---|---|---|
| Up to and including 19 in. | 8 in. | 58 lb. |
| 20 in. to 22 in. inclusive | 9 in. | 65 lb. |
| 23 in. and over | 10 in. | 73 lb. |

By the use of these small, light piston valves, the wear and tear on the valve gear is reduced to a minimum. As the section of packing ring is the same as for the large valves commonly used, the result is a greatly diminished tendency to buckle and score the bushing while crossing over the ports when superheated steam is used, trouble from this source being practically eliminated. Diagonal bridges are employed in the valve bushing to obviate grooving of the rings.

A notable feature of this arrangement is that outside steam pipes may be used, thereby eliminating all live steam passages from the cylinder saddle, as has become the accepted practice with superheat. In this case a tight cover plate is bolted over the steam pipe boss in the smoke box, and the steam passages in the saddle filled with a rich concrete mixture. A short bent section of steam pipe is used immediately above the chest to facilitate its removal without disturbing the pipes in the smokebox.

This valve was developed by the Economy Devices Corporation, 30 Church street, New York.

## HAND BRAKE FOR FREIGHT CARS

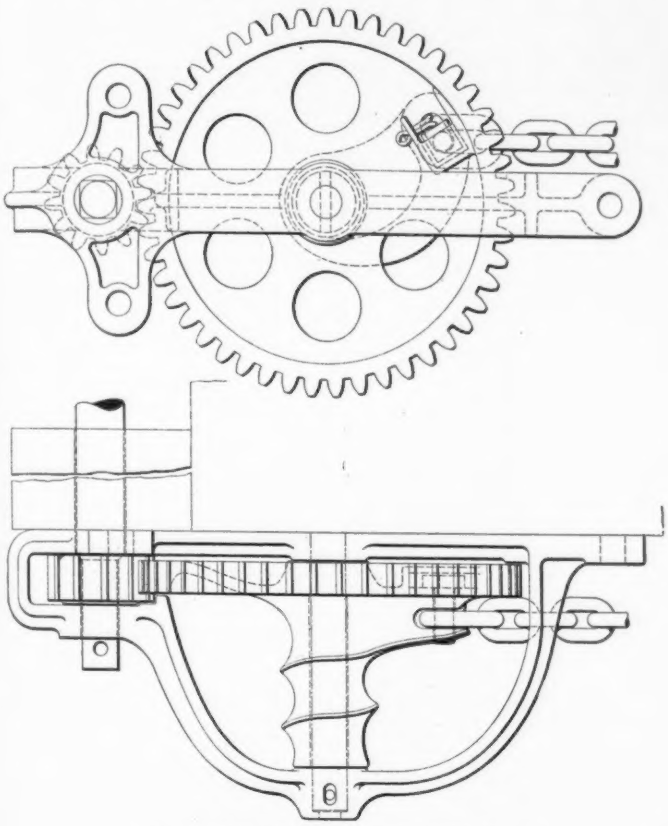
In an endeavor to secure a powerful hand brake for freight cars without sacrificing rapidity of action, the geared brake shown in the drawing has been developed by the National Brake Company, Buffalo, N. Y. This device, known as the Peacock freight car brake, consists of a malleable iron frame, a geared drum and shaft, and a pinion secured to the lower end of the brake shaft. The brake is operated by the usual type of shaft, the lower end of which is forged to a square section where it passes through the pinion, a cotter through the end securing it in position. Sufficient clearance is provided through the pinion so that finish is unnecessary and the space between the shaft and the gear readily frees itself from dirt which would tend to collect were a closer fit used.

The drum and gear are cast integral, holes being cored through the web of the gear to lighten it as much as possible and also to prevent the accumulation of dirt on its upper surface. The surface of the drum is formed into a shallow spiral groove, the bottom of which is over 2 in. in diameter. This eliminates the twisting and cutting of the chain, caused by the small drum usually employed. The upper portion of the drum is so designed that the center line of the chain follows a parabolic curve as the drum revolves, the end of the chain being secured at a point near the rim of the gear. This facilitates taking up the slack without loss of time or sacrifice of leverage when the effective application begins.

The chain is secured to the drum by a bolt in double shear which passes through a slotted hole. When in place the pull of the chain moves the bolt in the slot until its head occupies

a pocket on the upper surface of the web from which it cannot be directly removed. A cotter through a lug on the web of the gear prevents the head of the bolt from sliding out of the pocket should the pull on the chain be released. The drum revolves on a straight unfinished bar of cold rolled steel, the lower end of which rests in a pocket in the frame. The drum is bored out with ample clearance and is packed with graphite grease to prevent corrosion when the car is standing out of service. A cotter through the lower end of the bar and the frame prevents it from turning and cutting the frame.

The brake has a gear ratio of 12 to 48, and with a force of



Geared Hand Brake for Freight Cars

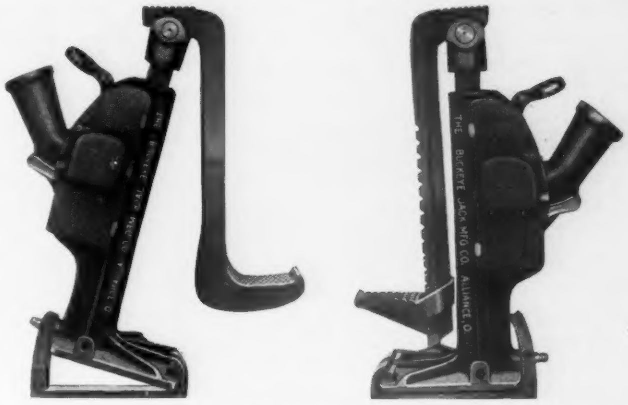
100 lb. exerted at the rim of a 16 in. brake wheel it is claimed to produce over 1,700 lb. pull on the chain. This is more than four times the force exerted on the chain by the usual type of hand brake where the chain is wound on a 1½ in. drum at the lower end of the brake shaft.

To successfully meet the conditions imposed upon a hand brake for freight equipment cars the cost must be low. With this consideration in view the use of finished parts has been avoided as far as possible, the only finished surface in the device being the bore of the drum. As shown in the drawings, the frame is designed for application to cars having platform end sills, but the brake may be designed for application to freight cars of any type.

## EMERGENCY JACKS

The jacks illustrated herewith include several interesting features which are especially valuable in equipment designed for emergency use. They have recently been added to the line of the Buckeye Jack Manufacturing Company, Alliance, Ohio.

The features of special interest are the swivel top, to which is pivoted an auxiliary hook for low lifting operations and an auxiliary heel plate which enables the operator to use the jack at an angle without blocking up. An adjustable auxiliary lift is shown on one of the jacks, which may be quickly adjusted to the load without sacrificing a portion of the lifting range of the jack. The foot of the jack is so designed that the auxiliary heel plate may be applied in two positions at right angles to each other, thus permitting the operation of the jack tilted either sideways or forward. The heel plate provides a substantial footing for the tool in any position without the necessity of special blocking.



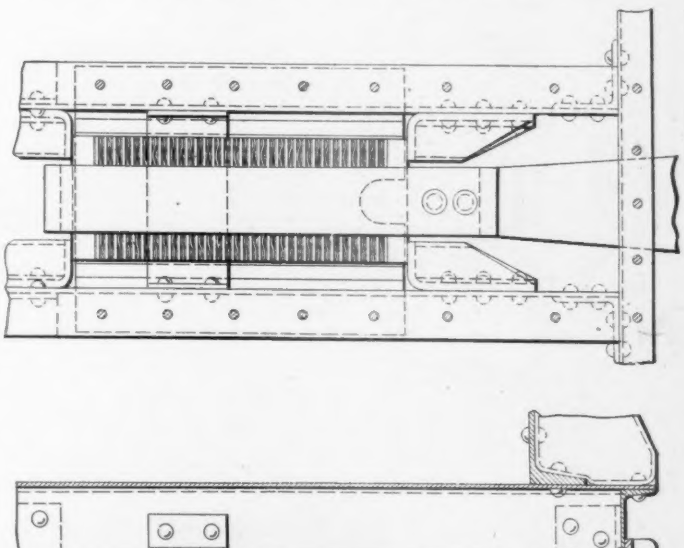
Jacks with Adjustable Heel Plates

When so desired it may be removed and the jack operated upon its own base.

In designing these tools special attention has been given to the elimination of unnecessary parts in order that the number of repair parts required may be kept at a minimum. The parts are easily assembled, and repairs may be made by the ordinary shop labor.

## FRICTION SPRING DRAFT RIGGING

The Slick friction spring draft rigging, which is shown in the accompanying illustration, consists of a number of springs formed of comparatively thin steel plates. These plates are square or rectangular and are corrugated, the axes of the corrugations being parallel to each other. The plates are placed so that the corrugations of each one are at right angles to those of the two adjoining ones. The arched portions of the plates are thus in contact with each other, and each plate forms an abut-



Slick Friction Draft Rigging

ment against which the adjoining plate operates. The device may be made either with single corrugated spring plates or where greater stiffness is desired the elements may be made up of two or more laminations each. The construction of the rigging is otherwise similar to that commonly used with other types of spring elements.

When under load the plates withstand stresses first by the spring action of the corrugated portions, which tend to flatten out under pressure, and in addition by the frictional resistance to the movement of the plates one upon another due to the flattening out of the corrugations. This action tends to dissipate a portion of the energy delivered to the draft rigging.

It is also claimed that the arch action of the corrugations tends to distribute the stress through the curved portion of each corrugation in such a way as to counteract to a certain extent the force in the tension side of the plates. The depth of the corrugations is such that when each plate is flattened under load the stresses will be about equal to the proper working stress for the material, thus insuring long life of the spring elements.

This draft rigging has been developed by the Cambria Steel Company, Philadelphia, Pa.

## VACUUM OIL BURNER

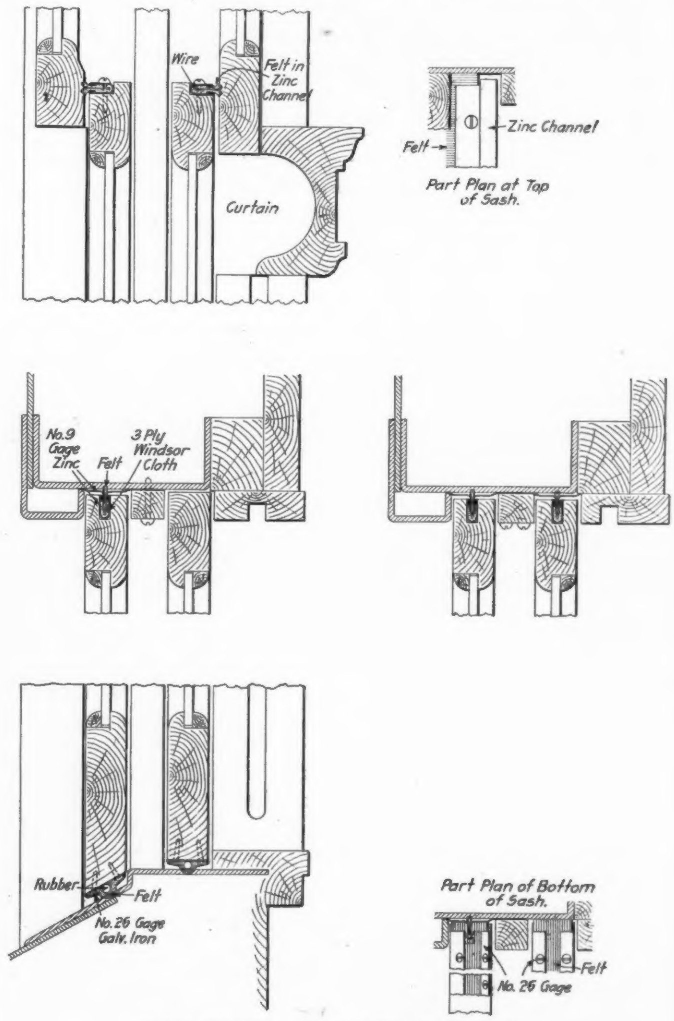
The Gustin-Bacon Manufacturing Company, Kansas City, Mo., has recently placed on the market a new type of oil burner that is especially adapted for service in railway shops. The chief feature of this burner is that the oil is drawn from the supply tank by a partial vacuum created in the oil pipe by compressed air passing over a series of holes in the end of the pipe, forming practically an ejector. Its application

Portable Oil Heater Equipped with Vacuum Burner

to a portable oil heater is shown in the illustration. By the use of this device the carrying of oil under pressures which vary from 60 to 125 lb. is entirely eliminated, and with it the fire hazard occasioned thereby. That the device is a "safety first" measure is readily recognized. The suction created in the oil pipe is sufficient to supply more oil than is generally required through the ⅜-in. pipe connecting the burner with the oil reservoir and the angle valve on the end of the burner is used to regulate the quantity of oil required to give the proper temperature. With this system the oil reservoir may be refilled while the furnace is being operated. The ordinary shop line air pressure is sufficient to operate the burner.

## CLOTH-LINED METAL WEATHER STRIPS

The accompanying illustration shows a method of weather-stripping car windows that has recently been applied to passenger equipment. It is an adaptation of a method that has been in successful use in buildings for the past four years. It is designed with the idea of maintaining a perfect seal on all four sides of the window, and at the same time giving a free movement in raising and lowering. On the sides of the window a channel of No. 9 gage zinc, lined with three-ply Windsor cloth, is inserted into the window for about 17/32 in. The

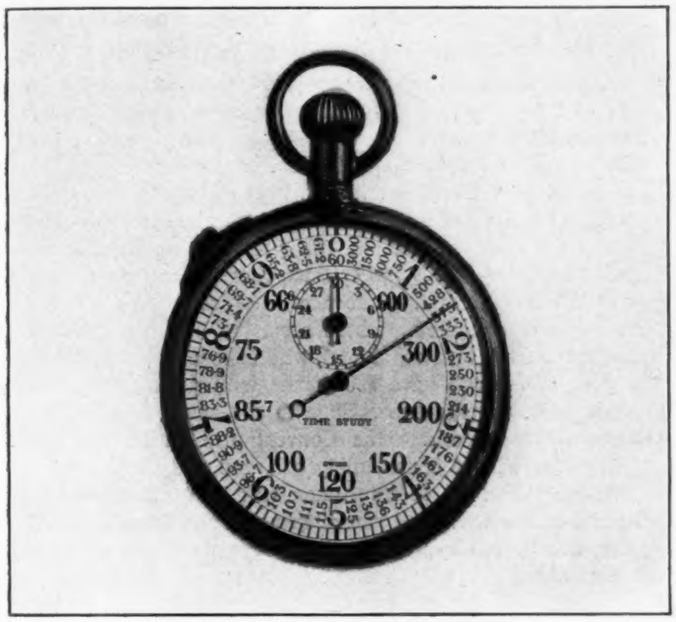



Metal Weather Strips with Cloth Lining

jamb-piece, which is also made of the same material, runs in this channel. The seal at the top consists of a similar channel with the felt inserted, as shown. This felt protrudes sufficiently to make a constant bearing when the window is closed. The bottom stripping is also clearly illustrated. A piece of No. 26 gage galvanized iron holds in place a strip of rubber surrounded by felt, which, when the window is closed, provides a seal at the sill. The greatest point of wear comes in the side weather-stripping, but the clearance between the jamb-piece and the channel is such that excessive wear of the cloth will not be possible. This weather-stripping is made and sold by the Athey Company, 1907 Michigan Boulevard, Chicago, Ill.

## TIME STUDY WATCH

A watch designed especially for making time studies and for determining the output of machines is shown in the accompanying illustration. The dial of the watch is divided into tenths and hundredths of a minute, which are the units used in taking time studies of machine tool operations. It is also provided with figures showing the hourly production for each two-hundredths of a minute. For example, as shown in the illustration, if an operation is performed in 0.16 of a minute, it is being performed at the rate of 375 per hour.

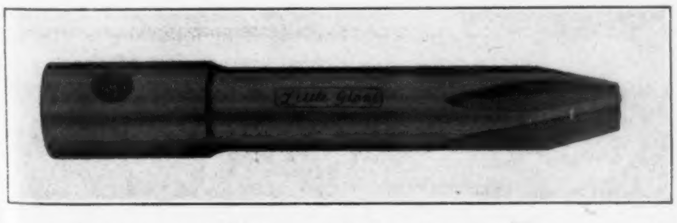


Stop Watch for Time Study Work

The watch is also designed to start and stop without the hand going back to zero. This is of special advantage when it is found necessary to take time out during any individual operation. The small dial in the center of the watch registers the minutes. The watch is started by pushing the slide on the side towards the stem and it is stopped by pushing this slide in the reverse direction. The hands are brought back to zero by pressing on the crown. This watch is sold by Mortimer J. Silberberg, Peoples Gas building, Chicago, Ill., who has the exclusive sales rights.

## INTERNAL GUIDE FOR PIPE THREADING TOOLS

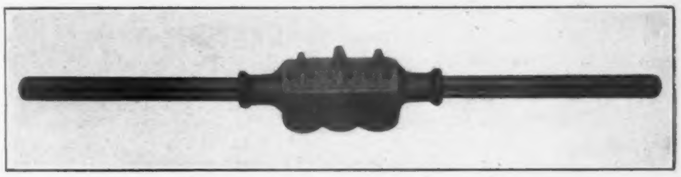
An internal guide with a reamer point for use in pipe threading tools has recently been placed on the market by the Greenfield Tap & Die Corporation, Greenfield, Mass. The internal



Internal Guide with Reamer Point for Use with Pipe Threading Tools

guide takes the place of the various forms of external or bushing guides which have been heretofore the only means of guiding the pipe stock to secure a straight thread. It not only effectively guides the dies onto the pipe but, in addition, reams the burrs from the inside of the pipe as it enters, thus saving an extra operation.

As shown in one of the illustrations, the guide is constructed with a slightly enlarged end which fits closely into a bushing on the side of the stock farthest away from the die. It is held in place by a set screw and may be readily removed. This



Pipe Stock Fitted with Internal Guides

guide is applied by the manufacturer to various types of pipe stocks, the one shown being fitted with three sizes of dies. One of the advantages of the use of the inside guide is that it permits threading on a much shorter projection than would be possible with a guide of the bushing type, which extends out in front of the die.

## BRINE TANK DRAIN VALVE

The accompanying illustrations show two positions of a new type of brine tank drain valve for refrigerator cars invented by W. A. Bourell, 5439 Aberdeen street, Chicago. The valve body is riveted to the lower end of the tank and the gate is controlled, as indicated, by means of a handle at the top of the car just inside the hatch plug. The opening in the valve is provided with a rubber gasket and the gate is

Brine Tank Drain Valve in Closed and Open Positions

forced to a seat by the lugs shown on the valve casting. In order to open the valve the hatch plug must be removed and conversely the valve must be closed before the hatch plug can be replaced. This valve has been used on a number of cars in the West and has required very little maintenance expenditure. It is so constructed that trouble will not be experienced with freezing.

# NEWS DEPARTMENT

The machine and blacksmith shops of the Seaboard Air Line at Portsmouth, Va., were destroyed by fire on the night of April 6.

The express car on Train No. 1 of the Louisville & Nashville was robbed on the line between Mobile and New Orleans, on the night of April 23, the safe in the express car being blown open. The baggageman was shot and dangerously wounded.

Of 336 fast freight trains run by the Baltimore & Ohio from New York, Philadelphia and Baltimore to Chicago, Columbus, Cleveland, Cincinnati and St. Louis, March 1 to 12 inclusive, only one suffered by delay, and this was the result of an unavoidable delay near Cincinnati.

The Lehigh Valley reports that 289 regular freight trains run during the month of March made a record of being on time 98.4 per cent. Eight daily through freight trains, leaving either Jersey City or Buffalo, arrived at their terminals every day on time. The New York State Public Service Commission, Second district, has advised the management that a recent ten-day check of l. c. l. freight between Buffalo and Geneva gave the Lehigh Valley 100 per cent for delivery on schedule time.

The carferry "Ontario No. 2," of the Grand Trunk, was successfully launched at the yards of the Polson Iron and Shipbuilding Company recently. The vessel was designed by William Newman, is of steel and cost $500,000. It is to run between Coburg, Ont., and Charlotte, N. Y. It is 318 ft. long, 54 ft. beam and 20.5 ft. molded depth. She has capacity for 30 loaded 70-ton cars. Her speed will be 17 miles an hour. The vessel is built as an ice breaker and is expected to make her way through ice 4 ft. thick.

F. W. Brazier, superintendent of rolling stock of the New York Central Lines East of Buffalo, addressed the Railroad Men's Christian Association, New York, on April 14, on the subject "What Constitutes the Equipment Department of a Railroad." Figures were given showing the amount of equipment used on the railways of the United States, and an outline given of the mechanical department organization of the New York Central. The equipment department of this road has approximately 18,300 employees, with a payroll of about $16,000,000 per year.

## MEETINGS AND CONVENTIONS

*American Railway Tool Foremen's Association.*—At the annual convention of the American Railway Tool Foremen's Association which will be held at the Hotel Sherman, Chicago, July 19-21, 1915, the following topics will be discussed: Special Jigs and Devices in Locomotive Repair Shops; Safety First in Regard to Machinery and Tools; Special Tools and Equipment for Maintenance of Pneumatic Tools; Grinding and Distribution of Machine Tools in Locomotive Repair Shops, and Standardization of Reamers for Locomotive Repair Shops. This subject, which was taken up at the last convention, has been continued and each member of the association is requested to report on it at the coming convention. The selection of an emblem for the association will also be considered.

*Meeting at Franklin Institute.*—A paper on Locomotive Stokers was presented at the Franklin Institute, Philadelphia, April 21, by W. S. Bartholomew, president of the Locomotive Stoker Company, Schenectady, N. Y. Lantern slides were employed showing in detail the construction of the various types of stokers now in service and a brief history of the development of mechanical stoking as applied to locomotives was given. There are now in successful service over 600 Street stokers, about 400 Crawford underfeed stokers and about 20 each of the Standard and the Hanna types. Mr. Bartholomew gave some figures showing the increase in tonnage effected by the use of mechanical stokers on large locomotives. The paper was discussed by representatives from the Baldwin Locomotive Works, the Chicago, Burlington & Quincy and the Baltimore & Ohio.

*June Mechanical Conventions.*—J. D. Conway, secretary-treasurer of the Railway Supply Manufacturers' Association, advises that already 178 exhibitors have arranged for space on Young's Million-Dollar Pier during the Master Mechanics' and Master Car Builders' conventions in June. Applications for space are coming in daily, and in spite of the business depression the indications are that the exhibits this year will be at least as extensive as, and possibly larger than, those of last year. The list of exhibitors shows a number of new companies which have never before exhibited. There seems to be little question but that the New Traymore Hotel will be open to receive guests by June 1. It will have 700 rooms with private baths and, it is said, will compare favorably with the newer and better class hotels of New York. The Convention Hall on the Million-Dollar Pier will be considerably enlarged and the exhibit space designated as Hotel Men's Annex will be enclosed with glass. Other improvements and rearrangements are being made in the space, which, it is expected, will add greatly to the effectiveness of the exhibit.

*International Engineering Congress.*—Volume IV of the transactions of the International Engineering Congress, which will be held at San Francisco in September, will comprise an important series of papers on the general subject of "Railways and Railway Engineering." This field will be treated under seven principal topics covering the relation of railways to social development; the present status of railways; the economic factors governing building of new lines; location; the physical characteristics of road including track and roadbed; bridges; tunnels; terminals; construction methods; signals; road equipment, including motive power other than electric; rolling stock in general; floating equipment; electric motive power in general. Approximately 27 papers are expected for this volume, prepared by authors representing 9 different countries. The list of authors includes many of the most eminent names in this field of engineering work throughout the world.

The volume will be well illustrated with charts, diagrams and half-tones, and will contain discussions contributed by leading American and foreign engineers.

The transactions of the congress as a whole will include nine or ten other volumes, covering the various fields of engineering work.

*Traveling Engineers' Association.*—The following is the program for the twenty-third annual convention of the Traveling Engineers' Association, to be held in the Hotel Sherman, Chicago, from September 7 to 10:

TUESDAY, SEPTEMBER 7

Morning session: Opening exercises and consideration of the subject: What effect does the mechanical placing of fuel in fireboxes and lubricating of locomotives have on cost of operation? W. L. Robinson (B. & O.), chairman.

Afternoon session: Recommended practices for the employment and training of new men for firemen; L. R. Pyle (M., St. P. & S. S. M.), chairman.

WEDNESDAY, SEPTEMBER 8

Morning session: The advantages of the use of superheaters, brick arches and other modern appliances on large engines, especially those of the Mallet type; J. E. Ingling (Erie), chairman.

Afternoon session: How can the road foreman of engines improve the handling of the air brakes on our modern trains? C. M. Kidd (N. & W.), chairman.

Evening: The entire evening will be devoted to examining the exhibits.

THURSDAY, SEPTEMBER 9

Morning session: Difficulties accompanying prevention of dense black smoke and its relation to cost of fuel and locomotive repairs; Martin Whelan (C. C. C. & St. L.), chairman.

Afternoon session: The electro-pneumatic brake; by W. V. Turner (Westinghouse Air Brake Company).

FRIDAY, SEPTEMBER 10

Morning session: The effect of properly designed valve gear on locomotive operating and fuel economy; W. E. Preston (Southern).

Afternoon session: Scientific train loading; tonnage rating; the best method to obtain maximum tonnage haul for the engine over the entire division, taking into consideration the grades at different points on the division; by O. S. Beyer, Jr. (Rock Island).

Election of officers and adjournment.

*International Railway Fuel Association.*—The following is the program of the seventh annual convention of the International Railway Fuel Association, to be held at Hotel La Salle, Chicago, May 17 to 20:

MONDAY, MAY 17

Morning session, 9:30 to 12:30.

Invocation; address by president; address by A. M. Schoyer, vice president, Pennsylvania Lines West; report of secretary-treasurer; appointment of committee to audit books of secretary-treasurer; appointment of special committees; unfinished business; new business.

Paper: Powdered Coal—Preparation and Use in Locomotive and Stationary Boilers; by W. L. Robinson, supervisor fuel consumption, Baltimore & Ohio.

Afternoon session, 1:30 to 4:30.

Paper: Fuel Conditions in South America; by J. W. Hardy, sales agent, West Kentucky Coal Company.

TUESDAY, MAY 18

Morning session, 9:30 to noon.

Paper: Analysis of Dependent Sequence as a Guide to Fuel Economy; by Harrington Emerson, consulting engineer.

Paper: Smoke Prevention; by E. W. Pratt, superintendent of motive power and machinery, Chicago & North Western.

Afternoon session, 1:30 to 4:30.

Paper: Standardization of Coal Preparation; by H. C. Adams, president, Jones & Adams Coal Company.

Report of committee on Fuel Stations, H. J. Slifer, consulting civil engineer, chairman.

WEDNESDAY, MAY 19

Morning session, 9:30 to noon.

Paper: Relation of Mechanical Stokers to the Fuel Problem; by committee on Firing Practice, D. C. Buell, director, the Railway Educational Bureau, chairman.

Paper: Fuel Oil for Locomotive Use; by G. M. Bean, Pacific Coast representative, American Arch Company.

Afternoon session, 1:30 to 4:30.

Paper: Waste of Fuel in Railway Stationary Plants; by Joseph W. Hays, combustion expert.

Report of committee on Storage of Coal.

THURSDAY, MAY 20

Morning session, 9:30 to 1:00.

Reports of Standing and Special committees on: Drafting Locomotives; Fuel Tests; Fuel Accounting; Constitution and By-Laws; Subjects for Eighth Annual Meeting; Election of Officers; Balloting for place of meeting, eighth annual convention; Adjournment.

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*The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.*

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass. Convention, May 4-7, 1915, Hotel Sherman, Chicago.

AMERICAN RAILROAD MASTER TINNERS, COPPERSMITHS AND PIPEFITTERS' ASSOCIATION.—W. E. Jones, C. & N. W., 3814 Fulton street, Chicago. Annual meeting, July 13-16, 1915, Hotel Sherman, Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen building, Chicago. Convention, June 9-11, 1915, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois Central, Chicago. Convention, July 19-21, 1915, Hotel Sherman, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Convention, June 22-26, 1915, Hotel Traymore, Atlantic City, N. J.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York. Annual meeting, December 7-10, 1915, New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Sta., Chicago. Annual meeting, October, 1915.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North Fiftieth Court, Chicago; 2d Monday in month, except July and August, Lytton building, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—S. Skidmore, 946 Richmond street, Cincinnati, Ohio. Annual meeting, September 14-16, 1915, Richmond, Va.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. G. Hall, 922 McCormick building, Chicago. Convention, May 17-20, 1915, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, July 13-16, 1915, Hotel Sherman, Chicago.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 17, 1915, Philadelphia, Pa.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty street, New York. Convention, May 26-28, 1915, Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen building, Chicago. Convention, June 14-16, 1915, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC. OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 14-17, 1915, Detroit, Mich.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. Frankenberger, 623 Brisbane building, Buffalo, N. Y. Meetings monthly.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 17-19, 1915, Hotel Sherman, Chicago.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. & H. R., East Buffalo, N. Y. Convention, September 7-10, 1915, Hotel Sherman, Chicago, Ill.

## RAILROAD CLUB MEETINGS

| Club | Next Meeting | Title of Paper | Author | Secretary | Address |
|---|---|---|---|---|---|
| Canadian | May 11 | Annual Meeting, Election of Officers | ...... | James Powell | St. Lambert, Que. |
| Central | May 14 | Locomotive of Recent Development | S. S. Riegel | Harry D. Vought | 95 Liberty St., New York. |
| New England | May 11 | Developments in Oxy-Acetylene Process | Henry Cave | Wm. Cade, Jr. | 683 Atlantic Ave., Boston, Mass. |
| New York | May 21 | Qualities of Good Steel Rails | Gustave Lindenthal | Harry D. Vought | 95 Liberty St., New York. |
| Pittsburgh | May 28 | ...... | ...... | J. B. Anderson | 207 Penn Station, Pittsburgh, Pa. |
| Richmond | May 10 | Safety First | George Bradshaw | F. O. Robinson | C. & O. Ry., Richmond, Va. |
| St. Louis | May 14 | Stereopticon Lecture; Special Addresses | J. W. Booth | B. W. Frauenthal | Union Station, St. Louis, Mo. |
| South'n & S'w'rn. | May 20 | Mikado Type Locomotives | Mr. Kline | A. J. Merrill | Box 1205, Atlanta, Ga. |
| Western | May 18 | Annual Meeting | ...... | Jos. W. Taylor | 1112 Karpen Bldg., Chicago, Ill. |
| Western Canada | May 10 | Annual Meeting | ...... | Louis Kon | Box 1707, Winnipeg, Man. |

# PERSONALS

*It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.*

## GENERAL

SHERIDAN BISBEE has been appointed fuel supervisor of the Boston & Albany, at Boston, Mass.

H. A. MACBETH, division master mechanic of the New York, Chicago & St. Louis at Conneaut, Ohio, has been appointed superintendent of motive power, with headquarters at Cleveland, succeding E. A. Miller, deceased.

D. T. MAIN has been appointed superintendent of motive power of the eastern lines of the Canadian Pacific at Montreal, Que., succeeding W. E. Woodhouse, promoted.

H. H. VAUGHAN, assistant to vice-president of the Canadian Pacific, at Montreal, Que., at his own request, has been released from the immediate supervision of the construction and maintenance of locomotives and cars, in order that he may devote his attention to important contract engagements in which he has become interested. He is being retained as consulting engineer.

W. E. WOODHOUSE, superintendent of motive power of the Eastern Lines of the Canadian Pacific at Montreal, Que., has been appointed chief mechanical engineer.

## MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

T. C. BALDWIN has been appointed master mechanic of the New York, Chicago & St. Louis, with headquarters at Conneaut, Ohio, to succeed H. A. Macbeth, promoted.

A. H. POWELL, master mechanic of the Western Pacific at Sacramento, Cal., has been appointed general master mechanic, with headquarters at that place.

## CAR DEPARTMENT

J. HODGSON has been appointed car foreman of the Canadian Northern at Montreal, Que.

CHARLES W. VAN BUREN has been appointed general master car builder of the Canadian Pacific, with headquarters at Montreal, Que., succeeding R. W. Burnett, resigned. Mr. Van Buren was born on October 18, 1867, in Rensselaer county, N. Y., attending the common schools until he was 16 years old, and for a year attended night school in New York City. He began railway work in 1889, on the New York Central & Hudson River. He was a carpenter at the West Albany shops until 1891, when he was made foreman, and two years later he was put in charge of car department work on the Adirondack division at Herkimer, N. Y. In 1896 he was transferred to Utica in charge of car department work on the Adirondack and the Mohawk divisions of the New York Central & Hudson River and the West Shore. He entered the service of the Canadian Pacific in July, 1905, as general car inspector on the lines east of Port Arthur. The following year he was appointed division car foreman of the Eastern division, remaining in that position until July, 1909, and then served as master car builder of the eastern lines of the same road, with headquarters at Montreal, until May, 1911. He then went to the Union Stock Yard & Transit Company, Chicago, as assistant general superintendent, remaining with that company until January, 1915, when he was appointed general foreman of the Milwaukee Refrigerator Transit & Car Company, at Milwaukee, Wis., which position he held until his recent appointment as general master car builder of the Canadian Pacific, as above noted.

## SHOP AND ENGINE HOUSE

J. M. KERWIN has been appointed general foreman, locomotive department, of the Rock Island Lines, at Cedar Rapids, Iowa, succeeding M. B. McPartland, transferred.

M. F. MCCARRA has been appointed roundhouse foreman of the St. Louis Southwestern at Illmo, Mo., succeeding P. H. Dwyer, resigned.

H. OSBORNE has been appointed works manager of the Angus shops of the Canadian Pacific at Montreal, Que. The Angus shops district, which has hitherto been operated as a separate unit, will hereafter be part of the Eastern Lines.

## PURCHASING AND STOREKEEPING

G. W. GEHAN has been appointed storekeeper of the Canadian Pacific at Hochelaga, Que.

G. H. JOBIN has been appointed storekeeper of the Canadian Pacific at Place Viger, Montreal.

F. D. REED, assistant to the vice-president and purchasing agent of the Chicago, Rock Island & Pacific, has been appointed general purchasing agent, with headquarters at Chicago. Mr. Reed was born April 22, 1868, at Fort Dodge, Iowa, and was educated in the public schools of Chicago. He entered railway service September 24, 1884, as wheel inspector of the car department for the Pennsylvania Lines West of Pittsburgh, at Chicago, which position he held until March, 1885, when he became clerk and timekeeper. In September, 1890, he was made chief clerk of the car department and held that position until July, 1895, when he was appointed assistant chief motive power clerk at Fort Wayne, Ind. In February, 1900, he was appointed chief motive power clerk and remained in that capacity until April, 1904. He then entered the service of the Chicago, Rock Island & Pacific as chief motive power clerk at Chicago. In February, 1906, he was made general storekeeper at Silvis, Ill., and held that position until May, 1910, when he was appointed assistant to the vice-president. On June 1, 1911, he was appointed purchasing agent.

F. D. Reed

EDWARD J. ROTH has been appointed purchasing agent of the Chicago, Indianapolis & Louisville, with headquarters at Chicago. Mr. Roth was born on March 4, 1882, at Rochester, Minn. He began railway work with the Chicago, Burlington & Quincy, in 1902, and was employed in the store department of that road until April, 1914, at that time holding the office of assistant general storekeeper. He then went to the Chicago, Indianapolis & Louisville, as supply agent, which position he held until his recent promotion to purchasing agent, as noted above.

E. J. URTEL has been appointed purchasing agent of the Buffalo & Susquehanna, with headquarters at Buffalo, N. Y.

## OBITUARY

James McGee, master mechanic of the Lorain, Ashland & Southern, with headquarters at Ashland, Ohio, died at his home in Lorain on April 6, aged 56 years.

# Supply Trade Notes

Wilber H. Traver, manager of the mining department of the Chicago Pneumatic Tool Company, died in Houghton, Mich., on April 15.

The Dearborn Chemical Company, Chicago, has opened an office in Edificio del Banco Anglo Sud-Americano, Buenos Aires, Argentine, in charge of Edward C. Brown.

The B. W. Parsons Co., dealing in railway material and mill supplies, has moved its offices in St. Paul, Minn., from the Pioneer building to 1306 Merchants Bank building.

A. Munch, who has been factory manager of the Maywood (Ill.) plant of the Hewitt Company, Chicago, has been appointed to the new position of service engineer for the same company.

The Chicago Pneumatic Tool Company, Chicago, has moved its New York office from 50 Church street to 52 Vanderbilt avenue, and its Boston office from 191 High street to 185 Pleasant street.

J. S Wright, formerly in the Detroit office of Manning, Maxwell & Moore, Inc., has been appointed manager of the Boston office, succeeding Walter M. Wood, who has resigned because of ill health.

L. L. Cohen, formerly with the H. W. Johns-Manville Company, has resigned to accept service with the Safety First Manufacturing Company, with headquarters in the Railway Exchange, Chicago.

A. J. Poole, formerly superintendent of motive power of the Seaboard Air Line, has become associated with the Galena Signal Oil Company in the capacity of railway expert, with headquarters in Atlanta, Ga., effective April 15.

M. A. Sherritt, manager of the Philadelphia branch of Manning, Maxwell & Moore, Inc., New York, has resigned to accept the position of vice-president and general manager of the Sherritt & Stoer Company, Inc., Philadelphia, Pa.

W. B. Carnes, formerly in charge of the New York office of the Lima Locomotive Corporation, has been appointed western representative, with offices in the McCormick building, Chicago. He has been succeeded in the New York office by William T. Middleton.

The C. W. Hunt Company, Inc., manufacturers of coal handling and conveying machinery and small motor trucks, has moved its New York office from 45 Broadway to the eleventh floor of the new building of the Adams Express Company, 61 Broadway.

The Chicago office of the Westinghouse Electric & Manufacturing Company has taken over the sale of Nuttall gears, pinions and trolleys, manufactured by the R. D. Nuttall Company, Pittsburgh, Pa., for the electric railway, mining and industrial fields in the Chicago territory.

William Disston, president of Henry Disston & Sons, Philadelphia, Pa., died suddenly of heart disease at his summer home near Philadelphia on April 5. Mr. Disston was born in Philadelphia on June 24, 1859. Besides being president of the saw company he was head of the Henry Disston & Sons File Company, and the Henry Disston & Sons Steel Works.

W. B. Huey, until recently president of the American Blue Print Paper Company, and A. H. Huey, until recently sales manager of that company, announce the formation of a new company, under the name of the Huey Company, with offices and plant at 59 East Adams street, Chicago. The company will engage in the production of blue, black line and other prints, litho productions, hectograph copies and photostat reproductions.

J. P. Rapp, a steel wheel specialist, has resigned from the Forged Steel Wheel Company, Pittsburgh, Pa., and allied companies, and has been appointed vice-president of the Gulick-Henderson Company, inspecting, consulting and chemical engineers, of New York. Mr. Rapp assisted Charles T. Schoen in developing his wheel, and has been directly connected with the industry from its earliest inception. He will give this item of railway equipment his particular attention.

The receivers of the United States Light & Heating Company, Niagara Falls, N. Y., announced to Judge Hazel of the United States District Court of the Western District of New York in Buffalo on March 30 that a complete reorganization of the company was now assured through the efforts of the stockholders protective committee which represents a controlling share of the preferred and common stock.

The Locomotive Pulverized Fuel Company has recently been organized, with offices at 30 Church street, New York, for the purpose of introducing the use of powdered coal, lignite and peat on steam locomotives. The officers are Joel S. Coffin, chairman; J. E. Muhlfeld, president; H. F. Ball, vice-president, and Samuel G. Allen, secretary and treasurer. This company has obtained the control of various practical appliances and processes which are essential to the effective and economical use of powdered anthracite and bituminous coal, lignite and peat in locomotive and other types of steam boilers used for railroad purposes, the equipment being also readily convertible, with practically no extra cost, for the use of fuel oil.

Joel S. Coffin, the chairman of the company, is also president of the Franklin Railway Supply Company, New York, which he organized in 1902, and vice-president of the American Brake Shoe & Foundry Company, Mahwah, N. J. He entered railway service when he was 17 years old as a shop apprentice and was later fireman, engineman, and road foreman of engines. In 1892 he entered the mechanical department of the Galena Signal Oil Company, becoming in 1896 manager of that department and in 1907 vice-president of the company.

John E. Muhlfeld, the president of the company, has been engaged for some years in railway expert work and has developed several important devices. He was born at Peru, Ind., on September 18, 1872. From 1889 to 1893 he attended classes in mechanical engineering at Purdue University, spending summer vacations in civil engineering work on the Peru & Detroit and as engine wiper and machinist apprentice in the Fort Wayne shops of the Wabash. After leaving Purdue he continued as apprentice, machinist and pit foreman until the summer of 1894 when the great railway strike of that year gave him an opportunity to become a fireman and engineman on the Wabash. As a result of the experience gained he was made, in November, 1894, engine house foreman at Peru. He later became general foreman and remained with the Wabash until February, 1899, when he left to become master mechanic on the Grand Trunk. In September, 1901, he became superintendent of machinery and rolling stock on the Canadian Government Railways at Moncton, N. B., leaving in October, 1902, to become assistant to the general superintendent of motive power of the Baltimore & Ohio at Baltimore. In February, 1903, he was made

J. E. Muhlfeld

superintendent of motive power at Newark, Ohio, and in June, 1903, general superintendent of motive power at Baltimore. He held this position until November, 1908, when he left to engage in railway expert work. In this connection he made inspections and reports of the characteristics of a number of roads, including the Kansas City Southern, of which, from November, 1910, to August, 1912, he was vice-president and general manager.

H. F. Ball, vice-president, is also president of the Economy Devices Corporation, New York. He entered railway service in 1884 as an apprentice on the Pennsylvania at Altoona. In 1888 he entered the drafting room at Altoona, and in 1890 was appointed chief draftsman of the car department of the Lake Shore. In 1892 he was made general foreman of the car shops at Cleveland, and two years later became general car inspector. In 1899 he was made mechanical engineer and in 1902 superintendent of motive power. In 1906 he left the road to become vice-president of the American Locomotive Automobile Company, but a few months later his jurisdiction was extended over the American Locomotive Company as vice-president in charge of engineering. In December, 1912, he left the American Locomotive Company to open an office as special consulting engineer, becoming early in 1913 president of the Economy Devices Corporation. Mr. Ball was president of the Central Railway Club in 1900 and of the Master Mechanics' Association in 1905-6.

S. G. Allen, the secretary and treasurer of the new company, graduated from college in 1891 as a lawyer. After practicing for about nine years he became general manager of the Franklin Air Compressor Company, now part of the Chicago Pneumatic Tool Company. He is now vice-president of the Franklin Railway Supply Company, secretary of the American Arch Company, treasurer of the Locomotive Superheater Company, vice-president of the Economy Devices Corporation, secretary of the American Materials Company and vice-president of the General Equipment Company, all of New York, and secretary of the executive and finance committees of the American Brake Shoe & Foundry Company, Mahwah, N. J.

At the annual meeting of the stockholders of the Joseph Dixon Crucible Company, held in Jersey City, on April 19, the former board of directors was re-elected for the ensuing year. The vote recorded was the largest ever represented at an annual election—19,519 shares out of a possible 20,000. The directors re-elected the following officers: George T. Smith, president; George E. Long, vice-president; J. H. Schermerhorn, treasurer; Harry Dailey, secretary, and Albert Norris, assistant secretary and assistant treasurer.

The Linde Air Products Company, New York, has purchased a factory site in St. Louis on Forest Park Boulevard, between Sarah street and Boyle avenue; and the work of erecting buildings will be started as soon as plans can be drawn and contracts awarded. The St. Louis plant will be the fourteenth erected by the company, and with its completion Linde oxygen will be distributed from 39 points. In addition to oxygen the Linde Air Products Company also produces nitrogen and other rarer gases contained in the atmosphere.

Merrill G. Baker has been appointed assistant general manager of sales of the American Vanadium Company. Mr. Baker was formerly assistant to the general manager of sales of the Cambria Steel Company. He was born in Indiana county, Pa., in 1880, from which his parents moved to Johnstown, Pa., in 1884. He worked his way through preparatory school, paying his expenses by doing night work as a telephone operator, and later attended Dickinson college, from which he graduated with the class of 1904. He entered the employ of the Cambria Steel Company on January 3, 1905. He worked in various of that company's operating departments until July, 1906, when he entered the sales department. In September, 1912, he was appointed assistant to the general manager of sales in charge of the rail and structural departments.

# CATALOGS

WATER SOFTENERS.—"The Kennicott Company" is the subject of a 29-page booklet prepared by Elbert Hubbard. The booklet is written in a breezy style and will be found of considerable interest.

TANK CALIBRATION CURVES.—The Universal Iron & Supply Co., St. Louis Mo., manufacturers of tanks, have issued a leaflet containing a calibration curve for horizontal, cylindrical tanks of any dimension. A copy of this curve will be sent to anyone on application.

DOOR HANGERS.—Catalog No. 12 recently received from the Richards-Wilcox Manufacturing Co., Aurora, Ill., illustrates in detail the line of door hangers, grindstones and hardware specialties produced by this company. The book is thoroughly illustrated and contains 296 pages, including an index.

ARC WELDERS.—The subject of Bulletin 1915-A from the Welding Materials Company, Inc., 114 Liberty street, New York, is Variable Voltage Welders. The subject of electric arch welding is dealt with at some length and a number of illustrations are given showing its application to locomotive and car work.

INSULATING BRICK.—"Good Furnaces Made Better" is the subject of a booklet issued by the Armstrong Cork Co., Pittsburgh, Pa., dealing with the Nonpareil insulating brick for furnaces and ovens. Illustrations and descriptive matter are included concerning the application of this type of brick to various furnaces.

NUT TAPPING MACHINES.—Tapper Talks, Nos. 1 and 2, have recently been issued by the National Machinery Company, Tiffin, Ohio, and deal with the National automatic nut tappers which operate on the bent tap principle. Illustrations of the machine at work are included and data given as to the advantages claimed.

VALVES.—The 1915 catalog, No. 18, from the Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., contains 140 pages giving in considerable detail descriptive and illustrating matter concerning the various valves manufactured by this company. The valves include a large variety of types for both steam and water service.

POWER PLANT OIL FILTERS.—Bulletin No. 10 issued by the Richardson-Phenix Co., Milwaukee, Wis., is devoted to the Peterson power plant oil filter and accessory apparatus for central oiling systems. A large number of half-tone and line engravings are included and considerable information is given concerning oil filtration.

ARCH TUBE CLEANERS.—The Lagonda Manufacturing Co., Springfield, Ohio, has just issued a 12-page catalog entitled Lagonda Locomotive Arch Tube Cleaners. This catalog deals with the subject of scale removal from arch tubes in locomotive fireboxes and describes cleaners designed specially for this purpose. Copies will be sent on request.

HYDRAULIC PUMPS AND VALVES.—This is the subject of a mailing folder issued by the Hydraulic Press Manufacturing Co., Mount Gilead, Ohio. This folder contains illustrations and detail dimensions of the various hydraulic equipment manufactured by this company. The folder is designated as bulletin No. 5000 and will be sent free on request.

COOLING CONDENSING WATER.—The Spray Engineering Co., Boston, Mass., has issued bulletin No. 101 dated March 1, 1915, illustrating and describing the Spray cooling pond system of cooling condensing water. A number of good illustrations are included showing various plants equipped with this system and data is given concerning them. Bulletin No. 151 of the same company is entitled Washing and Cooling Air for Steam Turbine Generators and contains eight pages dealing with this subject.